A NEW FAMILY OF HYDROIDEA.

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Dr. Semon with the kind regards of the author.

ARTICLE IV.—A NEW FAMILY OF HYDROIDEA, TOGETHER WITH A DESCRIPTION OF THE STRUCTURE OF A NEW SPECIES OF PLUMULARIA, BY W. BALDWIN SPENCER, M.A., PROFESSOR OF BIOLOGY IN THE UNIVERSITY OF MELBOURNE.

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The following deals with two hydroid forms obtained by Mr. J. Bracebridge Wilson, M.A., from the neighbourhood of Port Phillip. One of these is so distinct from any hitherto described that it must be taken as the type of a new Family, to which the name of Hydroceratinidæ is given, the other is a new and somewhat curious species of the genus Plumularia. The paper is, therefore, divided into two parts—(1) On the Hydroceratinidæ, a new family of the order Hydroidea, and (2) On *Plumularia procumbens*, a new species of the genus Plumularia.

(1) ON THE HYDROCERATINIDÆ, A NEW FAMILY OF THE ORDER HYDROIDEA.

The form in question undoubtedly calls to mind, in the general appearance of the dried specimens, one of the two genera which were placed in a distinct family—the Ceratelladæ—by Dr. Gray,* and, when this paper was read before the Royal Society of Victoria, I provisionally referred it to this family.† Dr. Gray had doubtfully

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† NOTE.—Up to the time of reading this paper I had only the necessarily somewhat imperfect descriptions (since taken from dried specimens only) of Dr. Gray and Mr. Carter to be guided by together with the figures of the former. Those of Dehitella bore a general resemblance to the specimen in question which was placed provisionally in that genus as a new species. Through the courtesy of Dr. E. P. Ramsay I have since been able to examine specimens of Ceratella and Dehitella from the Australian Museum, Sydney, and have received from there specimens obtained from the New South Wales coast, and from Lord Howe Islands by Mr. Whitelegge, to whom I am much indebted for kind assistance and information. The examination of these specimens has shown that the form with which this paper deals differs in such important points not only from the Hydractiniidæ but also from the Ceratelladæ that it must be placed in a separate family and I desire to here record my indebtedness to the authorities of the Australian Museum, Sydney, for the courteous assistance received from them.

* Proc. Zool. Soc., Nov., 1868.

placed the family in the group Porifera. Mr. Carter subsequently had the opportunity of examining both Dr. Gray's specimens and others of allied forms from New Zealand and the Cape, and rightly referred them all to the Hydroidea, placing them in the family Hydractiniidæ. This classification was adopted by Dr. v. Lendenfeld, and also, at first, by Mr. Bale in his valuable contribution to the literature of Australian zoology—the "Catalogue of Australian Hydroid Zoophytes."* Subsequently, Mr. Bale had the opportunity of examining spirit-preserved specimens with the hydranths and soft parts present, and, finding that these differed very considerably from those of the Hydractiniidæ in the presence of irregularly distributed capitate tentacles, &c., rightly separated them once more from the Hydractiniidæ, and adopted the name of Ceratelladæ for the family.† I was unaware of this short paper of Mr. Bale's until my attention was kindly drawn to it by Mr. Whitelegge, of the Australian Museum.

Whilst Dehitella in its general form (in the dried specimen) is somewhat like the specimen obtained by Mr. Wilson, there can be little doubt that the two are markedly distinct, even so far as the skeleton goes. Dehitella has most clearly what have well been called hydrophores‡, and agrees closely in this respect and in the general formation of its skeleton with Ceratella ; in their soft parts we may reasonably suppose that a corresponding agreement exists. Now the soft parts of the Ceratella are known,§ and they differ very strongly from those of the form with which this paper deals, so that we are probably correct in assuming that a similar difference exists between the latter and Dehitella. There is, on the other hand (as will be shown subsequently), quite as marked a distinction between the new form and any member of the family Hydractiniidæ as exists between the former and the Ceratelladæ, so that it is necessary to create a new family for its reception.

I have not so far, though numerous sections have been cut, been able to detect any reproductive elements, and therefore the description is incomplete, but will quite sufficiently serve to distinguish it from other forms.

Family Hydroceratinidæ..

Hydrophyton, consisting of a mass of entwined hydrorhiza, with a skeleton in the form of anastomosing chitinous tubes; the surface is studded with tubular hydrothecæ, into which the hydranths can be completely retracted. Hydranths sessile and connected with more than one hydrorhizal tube, claviform with a single verticil of filiform tentacles. Defensive zooids present with a solid endodermal axis and nematocysts borne at the distal end.

* Catalogue of Australian Hydroid Zoophytes. W. M. Bale, 1884.

† Bale, Proc. Linn. Soc., N.S.W., Vol. III., pt. 2, p. 748; also Brazier, Proc. Linn. Soc., N.S.W., new series, Vol. I. page 575; Whitelegge, *loc. cit.*, p. 578.

‡ Bale, Proc. Linn. Soc., N.S.W., 1888, p. 749.

§ Bale, *loc. cit.*

Clathrozoon wilsoni, n. gen. et. n. sp.

Hydrophyton irregularly sub-dichotomously branched, expanded in one plane fan-shaped. Main stem somewhat flattened and ridged, arising from an expanded base, dark brown in colour, with the surface showing a series of tortuous grooves. Smaller branches cylindrical. The whole composed of a number of branching and anastomosing tubes, with chitinous walls complete, except those of the most external ones. Hydrothecæ, which have the form of tubular spaces with chitinous walls, project slightly from the surface of all the branches, irregularly placed on the main stems, spirally on the branches. The whole, except the external openings of the hydrothecæ, completely enclosed in a thin transparent chitinous layer, from which arise very numerous cylindrical tubes enclosing the defensive zooids, and which forms also a funnel-shaped collar, projecting beyond the lips of the hydrothecæ.

Locality—Near Port Phillip Heads, Victoria. Mr. J. Bracebridge Wilson.

The description of the species is the same as that of the genus, and I have much pleasure in dedicating it to Mr. Wilson.

The specimens were obtained from two spots, each within a distance of five miles of Port Phillip Heads, that is, in Bass Straits, close to the Victorian shore. They were dredged in water of from twenty to twenty-two fathoms, and were placed directly into strong alcohol so that, like all received from Mr. Wilson, they are in excellent histological preservation. The polypes are, of course, in a state of retraction, and though very many sections from various parts of the hydrophyton have been cut, nowhere as yet have I been able to detect the presence of reproductive organs, or of individuals modified in connection with these, and though, therefore, unable to give any account of the reproductive organs, I have thought it advisable to describe and figure the animal carefully so far as can yet be done.*

The largest colony secured by Mr. Wilson measures 10in. in height, by 4in. in greatest width, and at first glance recalls to mind, to a certain extent, one of the dark coloured fan-shaped gorgonid forms. A cursory examination, however, at once shows that it does not belong to this group of animals.

If the whole colony be secured, it is found to be attached by a broad flattened-out base, attached to some solid structure; from this arises a single large stem, perhaps ⅜in. in thickness, slightly flattened out in one plane, and distinctly ridged (Fig. 1). From the edge at either side of the plane lateral branches are given off, varying much in size;

* That the animal is not at all common is shown by the fact that, though during this summer (1890-91), Mr. Wilson has been kind enough to spend a considerable amount of time in dredging, with the special object of procuring more specimens, not a trace of this hydroid has been brought up in the dredge, though the same ground which previously yielded it has been visited.

from these other branches are given off on either side, which again divide in a roughly but not constantly dichotomous manner, the smaller branches being cylindrical in shape. All the branches in the living and spirit-preserved specimens usually lie in the one plane, but when dried they often become slightly twisted, and thus thrown out of the plane. There is thus a considerable resemblance in general appearance between the form Clathrozoon on the one hand, and Dehitella and Ceratella on the other, especially between the two first mentioned, owing to the rounded branches of Dehitella. If, however, we come to examine the structure of the two more minutely, we find that the differences are very marked; whilst both have the skeleton in the form of a horny network, that of Clathrozoon has more the appearance of being composed of a series of anastomosing tubes, and rather less of the appearance of an open meshwork than is the case in the Ceratelladæ; but, what is of much greater importance, it presents on its surface a large number of circular openings at the extremities of slightly projecting chitinous tubes, which form true hydrothecæ. These are very distinct from what Mr. Carter and Dr. Gray aptly described as scoop-like projections of the chitinous network of the Ceratelladæ, though they unfortunately gave to them the name of hydrothecæ, that of hydrophore being more correct and suggestive of their real function, as at most they can but afford a support for the proximal part of the hydranth.

Skeleton (Figs. 4, 5, 6, 7, 8, 9, 11, 12, 13, 16).

When the branches of spirit-preserved specimens, with the soft parts present, are viewed under the lens, the surface is seen to be covered with a great number of tortuous grooves, filled with light yellowish coloured material—the cœnosarcal tubes. The edges of the grooves are formed by the chitinous perisarc of a dark-brown colour (Fig. 6), and arranged in a spiral manner are circular projections, the external opening of chitinous cylinders forming the hydrothecæ and containing the retracted polypes. These hydrothecæ are encircled by the tortuous grooves, and supported by extensions of the ordinary perisarc. The whole surface is covered over by an extremely thin and delicate colourless layer of perisarc common to the whole branch. This layer is not usually recognised until sections are cut, but the whole surface is seen to be studded with small cylindrical tubes, which are really formed from this thin layer and the spaces in which are continuous with the tortuous grooves below the latter (Figs. 7, 8, 9).

Sections show also that this thin layer rises up somewhat from the general surface, and is attached to the lips of the hydrothecæ; beyond the margin of the latter it is continued on so as to form a very thin collar-like extension, acting as an operculum. The arrangement is represented in the figures, especially in Fig. 13, which is meant to be a diagram showing the relationship of a hydrotheca to the

perisarc, as seen in a very thick section cut transversely to the length of a branch. This operculum-like structure is very thin and liable to be torn away, but is present in all well-preserved and cut specimens. Sometimes it projects as a stiff collar, sometimes (Figs. 4, 16) it is thrown into folds, and at others is withdrawn into the hydrotheca. With only specimens in which the polypes are completely retracted to examine, I cannot say how much of the body of the polype is covered by this thin collar when the animal is fully expanded.

When the soft parts are dissolved away by potash the whole branch appears to consist of a meshwork of tubes with chitinous walls (Fig. 11), which anastomose so freely that the skeleton appears, in surface view, to consist of an irregular chitinous network, which has a considerable superficial resemblance to the skeleton of a horny sponge, though this resemblance is even more strongly marked in the case of the Ceratelladæ. On cutting sections, however (Figs. 7, 8, 9), the tubular arrangement can be recognised. The structure is essentially identical in the branches and branchlets, whatever be the size, the only difference consisting in the greater number of tubes entering into the composition of the larger branches as compared with the smaller ones. The tubes (Fig. 7) run roughly parallel to the length of the branch, continually branching and anastomosing. The spaces which they contain vary much in calibre. Towards the exterior the chitinous walls are much stronger and thicker than in the interior, and the most external series are incomplete, forming grooves rather than tubes. The thin external layer of the branch, previously alluded to, touches the chitinous lips of these grooves (Figs. 8, 9), and thus a complete inclosure for the most external-lying cœnosarcal tubes is formed.

Sections also show that the larger circular openings, visible on the outside, lead down into tubular spaces, the walls of which are formed of chitinous material similar to that of the tube walls with which they are connected. These form the hydrothecæ, and the spaces within them are continuous with one or more of those within the tubes surrounding them (Figs. 4, 7, 12). The thin external chitinous (?) layer always passes up to be attached to the rim of the hydrothecæ. The cylindrical structures (P″) on this thin layer are very simple in form, open at both ends, and serve during life to contain the defensive polypes which are directly connected with the external layer of cœnosarcal tubes. (Fig. 5).

Measurements of the Skeleton.

Diameter of branch taken, ·7 mm.

Number of tubes, as seen in longitudinal section, entering into the composition of a branch of this size, 7—9; as seen in transverse section, 40—50.

Thickness of the tube, varying, but averaging about ·07 mm.

Thickness of wall of tube, ·0525 mm. at the exterior, some of those in the centre being not more than ·00525 mm.

Hydrotheca.—Transverse section, ·175 mm. — ·1225 mm.

Hydrotheca.—Longitudinal section, ·525 mm. (average).

Soft Parts. (Figs. 3, 4, 5, 10, 12, 14, 15).

The chitinous tubes are filled by the cœnosarcal tubes which branch and anastomose freely. No one of the latter tubes is more prominent than any other. The polypes are distributed over the whole surface, having apparently no definite arrangement on the larger stems or branches, but, in the smaller ones, a very distinct spiral arrangement (Figs. 6, 11). One corresponds to each of the hydrothecæ, seen in the skeleton, and is capable of complete retraction within the latter. When thus retracted the opening is protected by the thin collar-like projection formed of the outer layer of perisarc mentioned above.

Each polype has the typical hydroid form. It is somewhat tubular, with a conical hypostome, from the base of which arises a single circlet of solid tentacles, which vary in number from six to ten, and are provided with minute nematocysts, the threads of which are short, stiff, and unbarbed. When the tentacles are retracted they curl over towards the mouth, much in the same manner as do those of Pedicellina, amongst the Polyzoa.

The body of the polype is formed of the typical layers—an ectoderm of somewhat columnar cells, an endoderm of larger cells less defined in shape, and between the two a very strongly marked layer of mesoglœa (.00875 mm. in thickest part). From the bases of the ectoderm cells pass off long processes (Fig. 14), much more strongly marked than is usual in hydroid forms. In its greatest breadth one of these fibres measures ·0058 mm. They give rise to a circular band of what are evidently in function, "muscle fibres." In figure 14 these are represented as seen when an oblique longitudinal section of a polype is cut.* Possibly some of them may have lost their connection with the ectoderm cells from which they have been derived. Each has a very definite outline and contents, which, when stained, have a somewhat granular appearance. They all lie external to the mesoglœa, and form a very definite band round the body of the polype, the position of which is represented in the diagram (Fig. 12).

Sections, transverse and longitudinal, show that the basal ends of the polypes are continuous with more than one (sometimes as many as four or five) of the

* These bear a considerable resemblance to those described by Weismann as occurring in the cœnosarc of *Plumularia echinulata.* See Entstehung der Sexualzellen bei den Hydromedusen, Pl. VIII., Fig. 9*b*.

cœnosarcal tubes. In this they resemble the polypes in the group Hydrocorallinæ. The cavities of the polypes and of the meshwork of tubes are hence directly continuous. The tubes are formed of the two primary layers with, if present at all, an extremely thin layer of mesoglœa between them. The endoderm is always unilaminar and distinct; the ectoderm is composed of smaller cells, the nuclei, but not the outlines, of which are clearly marked. It appears to be frequently more than one cell in thickness, and to be irregular in outline, spirit specimens showing projections (Fig. 10) which come in contact with the chitinous walls. Probably during life there is very little space between the hard and soft parts. Within the cœnosarcal tube are frequently seen large globular structures containing darkly staining portions (Fig. 10. x.)

The whole of the external layer of cœnosarcal tubes is studded over with an enormous number of small defensive polypes of very simple structure (Figs. 3, 5, 15). One corresponds to each of the cylindrical structures which rise up from the outer thin perisarc layer, and consists of a stalk and a head. The former is directly continuous with the cœnosarc tube, and consists of an internal axis, the nature of which is difficult to determine. It is solid, and contains no prolongation of the tubular canal of the cœnosarc, but appears to be continuous with the endoderm, though I cannot as yet make out the cellular structure. It is very much shrunken in spirit specimens. The outer layer is thin and continuous with the ectoderm of the cœnosarc (Fig. 15). In spirit-preserved specimens it has the appearance of a thin layer of granular protoplasm with nuclei, the diameter of which is greater than the thickness of the protoplasmic layer, in which the outline of cells cannot be distinguished. No trace of muscle elements can be distinguished.

The head consists of a little mass of nematocysts, with the remnants of the cells, which have given rise to them, and the nuclei of which can be clearly seen. Each nematocyst is fusiform in shape, and the whole form a little group lying close to the open end of the cylindrical tube, through which the threads can doubtless be ejected. None of the nematocysts have the threads put out, and their exact form cannot be therefore described.

In relative size and structure these defensive polypes resemble more than anything else the machopolypes of the Plumulariidæ, and have no resemblance to the defensive polypes of Hydractinia or Podocoryne, whilst none have as yet been described in the Ceratelladæ.

In figure 3 is represented a diagrammatic restoration of a branch of the colony only the soft parts being drawn. The upper surface is supposed to have been cut away, and the network of cœnosarcal tubes is shown branching and anastomosing. The connection of the alimentary polypes with the tubes is drawn, and the small

defensive polypes are shown arising from the outermost layer of cœnosarc. The hard skeleton parts represented in figure 11 occupy the spaces between the tubes in figure 3, the polypes corresponding in position to the large circular openings leading down into the hydrothecæ. The general relationship of the polypes to the skeleton and the cœnosarcal tubes is represented diagrammatically in figure 12.

Affinities of the Hydroceratinidæ.

Clathrozoon differs in important points from any hydroid hitherto described, and it is somewhat difficult to determine its affinities, more especially in the absence, as yet, of any knowledge of its reproductive elements.

At first glance it would appear to be related to the Ceratelladæ, but this is simply in consequence of the superficial resemblance in the skeleton of the two groups; each consists of a branching mass of entwined perisarcal tubes, and here the resemblance ends, for, whilst the branching network of tubes may be compared with that constituting the skeleton of the Hydractiniidæ and the Ceratelladæ, there are present two structures entirely wanting in the members of these two families, (1) the hydrothecæ, and (2) the external layer of thin perisarc, with its projecting cylindrical tubes. The first of these structures are quite unlike those of any other hydroid in their simple shape, the thickness of their walls, the relation of these to the surrounding perisarc tubes, and the number of openings leading through the wall into the enclosed space. At the same time, if the cavity in the scoop-like projection, formed of a small network of perisarcal tubes in the Ceratelladæ, were to become deeper and to penetrate the substance of the branch, and if the branches of the network bounding the cavities thus produced were to "run together" and thus give rise to a tubular structure, in which apertures were left, we should have produced a structure similar to the hydrothecæ of Clathrozoon. The second of these structures is, apparently, not present in any other hydroid, and the manner of its origin is difficult to conceive. There is no such external layer of cœnosarc investing the colony as is present in the Hydractiniidæ, and which might be supposed to secrete such a layer. On the contrary, the surface of the colony shows a series of much branching tortuous perisarc tubes, each incomplete externally, and the whole covered in by this thin continuous layer, which does not give the idea of having been formed as a separate outer covering for each most external tube, though it must apparently have been produced in this way. The little cylinders arising from it enclose each, it is important to notice, a defensive zooid, which arises directly from the cœnosarcal tube immediately below. In one or two of the sections cut transversely near to the end of a growing branch, the perisarc tubes appear to have a thin innermost lining distinguishable from the rest of the perisarc; possibly this may be comparable to this outer layer, but at all events the latter, as shown in sections, passes continuously from lip to lip

of the outer grooves, and has nothing to do with any layer lining the latter internally. That it is connected in development with the soft structures in these there can be little doubt if only on account of its relationship to the protective zooids to which they give rise.

The extension of this layer beyond the mouth of the hydrothecæ so as to form, as it were, an operculum for these, is a curious feature, and one not met with, so far as I am aware, in any other hydroid. This particular part is very flexible, being capable of being thrown into folds (Fig. 16), or even of being pulled back within the outer rim of the hydrotheca by the retreating zooid. Taken altogether the skeleton, though in certain respects showing a resemblance to the Hydractiniidæ and Ceratelladæ, differs essentially from that of these forms in the two important points dealt with above.

In dealing with the soft structures we find a most curious combination of characters, each one characteristic of hydroid forms, belonging to groups perfectly distinct from one another.

The network of cœnosarcal tubes resembles, to a certain extent, that of the Hydractiniidæ, Ceratelladæ and Hydrocorallinæ, but even here we have to note the entire absence of an external continuous layer, characteristic certainly of the first and third, and, probably, also of the second group.

The alimentary polypes are sessile, and distinctly "claviform," that is, have tubular bodies with a conical hypostome and a single circlet of simple solid tentacles, in which points they resemble the genus Clava. Those of the Ceratelladæ*, on the other hand, have scattered capitate tentacles, and in the Hydractiniidæ they are provided with a strongly developed hydrocope.

The gastrozoids again resemble those of the Hydrocorallinæ, and differ from all others amongst the Hydrozoa in being connected with several of the cœnosarcal tubes.

The defensive zooids, or dactylozooids, resemble more than anything else, certain individuals characteristic of the Plumulariidæ, to which the name of "machopolype" has been applied. They consist of a solid stalk bearing a number of nematocysts at its free end, each zooid being enclosed in a distinct protective case or nematophore.

The structure of the gastrozooids thus calls to mind the genus Clava, that of the dactylozooids the family Plumulariidæ, and the relationship of the gastrozooids to the cœnosarcal tubes, the sub-order Hydrocorallinæ. This combination of characters, together with the nature of the skeleton, serves to render the Hydroceratinidæ distinct from any family of Hydroidea yet known.

* Bale, *loc. cit.*

2. A New Species of Plumularia.

This form was dredged by Mr. Wilson in Port Phillip, and differs, as far as I can ascertain, from any yet described. In (1) that the nematophores are perfectly independent of the hydrothecæ, (2) that no intrathecal ridge is present, (3) that the hydrothecæ are cup-shaped, with smooth untoothed margin, and are set at some distance apart from one another, the form in question shows the features characteristic of the group to which Allman gave the name of Eleutheroplea.

The arrangement of the hydrothecæ would prevent it from being placed in any of the three divisions—Isocola, Anisocola, and Monopyxis—into which Kirchenpauer proposed to divide the genus.

The species may be described as follows:—

Plumularia procumbens, n. sp.

Hydrocaulus upwards of 6in. in length. The whole colony procumbent with large polysiphonic branches running in a roughly horizontal direction. From one side of these principally arise smaller polysiphonic branches, all lying in one plane. From the sides of the branches arise numerous pinnæ (at largest ¼in. in length) irregularly arranged; in addition to these, hydrocladia (pinnules) may arise direct from the hydrocaulus. Two pinnules, alternate, arise from each joint of the primary pinnæ. Pinnules composed of alternate small and large joints, the latter only bearing hydrothecæ and nematophores. Nematophores bithalamic with simple terminal aperture, one beneath each hydrotheca, two at the level of the mouth of the hydrotheca, all independent of the latter. Two nematophores in the angle between the pinnule and main stem of the pinna; nematophores scattered irregularly in great numbers over the surface of the polysiphonic stem and branches.

Colour.—Light-brown stems.

Hab.—Port Phillip, Mr. J. Bracebridge Wilson.

The colony reaches a considerable size, and from the fact that the main branches run in one direction (Fig. 20) with the smaller ones arising principally from one side, it is inferred that in all probability it is procumbent in habit. The branches of the hydrocaulus are all polysiphonic and strong, the pinnæ and hydrocladia, which arise from them, being very small indeed in comparison. The two latter are given off all round the branches, and reach at most the length of ¼in., whilst the main branch may be 6in. in length.

Skeleton.

(a) Structure of large branches (Figs. 24, 25, 26, 27, 28).

Under the lens the tubes making up the branches can be clearly seen, the surface being marked by darkish brown lines, due to the edges of the perisarcal tubes seen in optical section (Fig. 25). The tubes on the exterior run parallel to one another along the length of the stem, branching very rarely. From the surface arise irregularly, and on all sides—(1) large pinnate shoots, the proximal parts of which are covered with one or more layers of dark-brown perisarc, within which only one tubular cavity is contained; (2) smaller branches (hydrocladia), corresponding to the pinnules in structure; (3) a great number of nematophores, or protective cases, for the minute defensive zooids which are characteristic of the group.

In transverse section (Figs. 27, 28) the branch is seen to be made up of a great number of tubes—as many as 40-50 in a branch of average size—the number varying with the size of the branch.

Each tube has a definite and thick perisarcal wall, which shows clear indications of arrangement in layers. In places the cavities within the tubes are seen to be (Figs. 24, 27, 28) in communication with one another. A striking feature of both transverse and longitudinal sections is the presence of a distinct central tube, always clearly recognisable, both on account of its size and the slightly yellow colour of its walls when compared with the surrounding ones (Fig. 24). This central tube, which, from its relations to the other parts, is probably to be regarded as homologous with the main stem of a monosiphonic form, passes along all the branches of the colony, and from it arise *every one* of the pinnæ and hydrocladia, though, as will be shown shortly, these may be also connected with the other tubes which go to form the polysiphonic stem. Professor Allman has figured* in *Aglaophenia coarctata* a connection existing between the various tubes of a polysiphonic stem, and this is most clearly seen in the species under consideration. The connection is, however, somewhat different from that obtaining in *A. coarctata*, which is thus described by Allman :—" Communication is effected by very short processes, which are given off from the component tubes, those of two juxtaposed tubes meeting one another and inosculating in such a way as to suggest the conjugation of a zygnema." In longitudinal section (Fig. 24) the various tubes are seen to be arranged so that they run parallel to the central one, and at intervals their walls are pierced by apertures. Where the pinnæ and hydrocladia pass through, the walls of the latter are connected with those of the stem-tubes, and apertures are formed opening into the cavities of the latter.

(b) Structure of the pinnæ, etc. (Figs. 21, 22, 23, 25, 26).

The origin of these from the stem is shown in figure 25, their structure in figures 21, 22, and 26.

* " Challenger " Reports, Hydroidea, Part I., Plumulariidæ.

The basal portion of each pinna is strengthened by the development of a very strong layer of dark brown coloured perisarc, continuous with that of the tube walls. This thick external layer ends abruptly just before reaching the distal end of either the first or second joint (Fig. 25). Each joint beyond the first one or two carries two pinnules. There appears to be a slight variation in the most proximal joints; sometimes the first, sometimes the first and second, differ from the rest, in bearing each only one pinnule.

The pinnules are alternate, and consist of a varying number of joints, which are alternately shorter and longer, the latter only bearing the hydrothecæ and nematophores (Figs. 21, 26). This arrangement is constant in all specimens which I have examined. In other Plumulariæ the pinnules of which are composed of alternately longer and shorter joints, such, for example, as *P. setaceoides, goldsteini, delicatula*,* the shorter ones always bear a nematophore. This is absent in *P. procumbens*. The hydrothecæ are cup-shaped, with a smooth margin, and are placed on the side facing the central stem of the pinna. The most distal pinnules carry one hydrotheca each, the proximal as many as six. The cavity is separated from that of the joint by a septum pierced by a circular opening, which lies near to the external wall. There is no trace of an intrathecal ridge.

The nematophores are three in number on each of the larger joints; one is placed below the hydrotheca, two at the level of its upper margin. Each is bithalamic with the terminal chamber cup-shaped, and the proximal one somewhat canaliculate. The walls are thin (Fig. 22), except where the division into the two parts is formed, at which spot they thicken considerably, and give rise to a circular ridge projecting upwards into the distal chamber. The opening is single and terminal, and each nematophore is only attached by its proximal end, where the walls are thin, and may be thrown into slight folds.

The walls of the pinnule joints show internal ridges, which are always more prominent on the side facing the central stem of the pinna, and thin away towards the opposite surface. They are always arranged thus—(1) In the larger joints there is a ridge close to each extremity, with a third one corresponding in position to the septum of the hydrotheca; this varies much in development, being sometimes scarcely noticeable. (2) In the smaller joints there are uniformly two ridges. (3) In the projection from the joint of the pinna bearing the pinnule there is always one ridge. Taken altogether the result is that each line of division in the pinnule has one ridge immediately on either side of it (Fig. 21).

In the axil of the pinnules there are present—(1) Two nematophores corresponding in structure exactly to those described above, (2) between these a curious

* Bale. Catalogue of Australian Hydroids, Pl. XI.

structure formed of the perisarc, having the shape of a cone with the apex cut off (Fig. 21). The space within the latter communicates by the narrow end with the exterior, and by the broader with the cavity of the pinna joint. Into it cells of the ectoderm may enter to a slight degree, but more usually it appears to be unoccupied (in spirit-preserved specimens), and I am quite unable to attach any meaning to it, though it is a perfectly constant structure. It has nothing to do with the reproductive structures. Possibly it may serve as a means of allowing of the ingress and egress of water to and from the perisarcal tubes. Any space between the ectoderm and the perisarc in the very numerous tubes which compose the colony must presumably be filled by liquid. The openings leading into the hydrothecæ and nematophores from the stem are small and narrow, and quite filled up by the soft parts. When sudden contraction takes place part of the soft portions must be withdrawn through these openings and occupy space within this perisarcal tube previously, presumably, occupied by fluid. If there be some means of expelling this fluid then the sudden contraction of the polypes and machopolypes is rendered more easy. It may be that these openings serve this purpose. The openings are guarded, as it were, by two machopolypes.

Soft Parts (Figs. 17, 18, 19, 24).

(*a*) Larger branches.

These are all polysiphonic. The cœnosarcal tubes of which each is composed may be divided into two divisions—(1) a central one, (2) others varying in number and surrounding this. The tubes very rarely branch in such a way that two running longitudinally arise from a common one, though (Figs. 24, 27, 28) they frequently are united with one another by short transverse branches passing through openings in the perisarcal walls. Each consists of ectoderm and endoderm containing a cavity. From the outermost series arise a great number of minute machopolypes or defensive zooids. *The central one gives origin to all the branches passing out into the pinnæ and hydrocladia*, with which the branches are irregularly studded. As they pass from the centre to the external surface they are connected with a varying number of the surrounding cœnosarcal tubes, a feature which is especially marked in the case of the pinnæ (Figs. 17, 24). This arrangement is clearly seen when sections are cut, and has not, so far as I am aware, been noted before. Bale,* in speaking of the structure of the stem and branches in the Plumulariidæ, says that in most polysiphonic species "the primary jointed stem is slender (the requisite strength being given by the compound stem, which is only developed as the zoophyte increases in size), and the branches spring, not from the jointed stem, but from the supplementary tubes which grow up in contact with it. For example, in

* Genera of the Plumulariidæ, with observations on various Australian Hydroids. Proc. R. S. Victoria, 1886.

Aglaophenia longicornis we find at the back of the original slender-jointed stem a stouter secondary tube, *and from this spring, at regular intervals, the alternate pinnately arranged branches.** . . . . Keeping in mind the hydrorhizal origin of the polysiphonic stem we see that in *Aglaophenia longicornis*, for example, every one of the main pinnæ is equivalent to a separate shoot of such species as *A. parvula*, a fact which is further illustrated by the presence, near the base of the stem in the latter species (and, indeed, in many others), of a long oblique joint similar to that which exists near the base of each pinna in *A. longicornis*. . . . . *I have not hitherto met with any species with branches springing both from the jointed stem and the added tubes.*"*

It will be seen at once that an important difference exists in this respect between the species now described, and those examined by Mr. Bale, and, so far as I am aware, any other investigator. Not only is there a very distinct connection between the soft and hard parts of all the tubes of the polysiphonic stem, but the central one, though distinguishable from the rest, has the same fundamental structure as the latter so far as its walls are concerned, and shows no traces of joints.† The question naturally arises What elements are we to consider as entering into the structure of the polysiphonic stem in this form?

We may regard it as composed of—

(1.) A central tube equivalent to the hydrocaulus of a monosiphonic form, which is surrounded by a series of added but modified hydrorhizal elements, or

(2.) A number of hydrorhizal elements forming branch-like structures, and giving off pinnæ, or

(3.) A number of hydrocauli in close apposition to one another.

The last is the most improbable, since, if it were the case, we might expect pinnæ to be given off from all or any of the tubes composing the stem, whilst they *all* arise primarily from the central one. The same objection applies to the second, and the distinction which undoubtedly obtains between the central and all the other tubes seems to point to the fact that the former is the fundamental portion, the latter being secondary structures. At the same time a hard and fast line of distinction between hydrocaulus and hydrorhiza cannot possibly be drawn. In some forms of Plumulariidæ we find the pinnæ arising directly from the hydrorhiza, in others they arise from the sides of a hydrocauline structure which grows upwards from the

* The italics are mine.

† At the free extremity of each branch it is continued directly on into a jointed stem forming the centre of a pinna, and may probably be regarded as having lost its jointed nature subsequent to its being completely enclosed by the surrounding tubes of the polysiphonic stem.

hydrorhiza. Sometimes the structure bearing the pinnæ, or the central stem of the pinnæ itself, may be strengthened by the addition of tubes clearly growing up from the hydrorhiza. These tubes, in some monosiphonic forms, may be feebly developed, whilst in typical polysiphonic ones apparently homologous structures may be constant and greatly developed. In the former case the distinction between hydrocaulus and hydrorhiza is clear enough, but then if the true polysiphonic form be investigated, we find that the supplementary structures grow around the primary jointed stem, and (1) finally (as in *Aglaophenia longicornis*) give rise to the pinnate branches, just as does the hydrocauline tube in such a form as *P. falcata*, the jointed stem bearing no branches; or (2) they form (as in *P. procumbens*) an enclosing mass for the original tube which alone gives off the pinnæ, though these may be connected with the hard and soft parts of the enclosing branches. Thus what must be regarded as homologous structures, may either (1) be feebly developed, and retain their original hydrorhizal nature; or (2) be strongly developed and *(a)* give rise to pinnæ, and, as it were, usurp the function of the original hydrocauline tube which they support, or *(b)* assume an intermediate form, the original tube which they inclose alone giving rise to pinnæ, with which, however, as well as with the former they are in organic connection.

(*b*) *Pinnæ, etc.*

There is little to say with regard to the structure of the soft parts contained in the pinnæ; the hydranths have the form typical of the genus Plumularia, with the body divided into two parts by a central constriction, the distal part bearing a single circlet of solid tentacles at the base of a broad hypostome, the proximal half being somewhat globular and presenting no special feature.

The machopolypes of the main branches and the pinnæ are of precisely similar structure, corresponding to those of other forms which Lendenfeld has distinguished as "guard animals with corticating capsules."* There is no trace of any with adhesive cells such as are found in the genus Aglaophenia.

Each machopolype consists of a proximal tubular part lying in the proximal half of the nematophore and a distal swollen part, which contains rounded nematocysts. I have been unable to study the living form, and have only seen spirit specimens, in which the soft parts are of course much contracted; in these, lines running from the head down the stalk probably indicate muscle fibres, the machopolype being capable of great extension.

In figure 17 is represented a restoration of the soft parts of a small portion of one of the polysiphonic stem, together with one of the hydrocladia and pinnæ which arise from it.

* Zeitsch. f. Wissen. Zool., Vol. XXXVIII., p. 335.

(c) Reproductive structures.

The only specimen bearing reproductive structures was a male colony. The gonothecæ (Figs. 18, 19, 23) are simple and pear-shaped, with a large terminal opening and short stalk springing from the axil of a pinnule. Each contains one gonophore (Fig. 18), which in longitudinal section is seen to arise from the blastostyle and to fill nearly the whole cavity. The blastostyle in the spirit-preserved specimen examined was much shrunken with a terminal swelling (D) below the opening of the gonotheca. The cell-layers could not be distinguished. The two prominent parts of the gonophore are the mass of sperm cells (sp), which stain deeply, and the spadix (Fig. 19, end.) Outside the sperm cells a very thin layer of ectoderm can be distinguished. I failed after long searching to recognise any trace of reproductive elements in the cœnosarcal tubes or blastostyle, or any appearance of the formation of more than one gonophore in each gonothecæ, though in *P. echinulata* Weismann states that very often a second gonophore may be found before the contents of the first have passed out.* In *P. halecioides* also it seems that two may be present at the same time.†

* Entstehung der Sexualzellen bei den Hydromedusen, p. 180.

† *Loc. cit.*, p. 184.

DESCRIPTION OF PLATES.

Plates 17, 18, 19, and 20 refer to *Clathrozoon wilsoni*.

Plate 17.

Figure 1.—The skeleton of a dried specimen of *Clathrozoon wilsoni*, life size, from a photograph.

Figure 2.—Skeleton of part of a colony of *Clathrozoon wilsoni*, drawn from a spirit specimen.

Plate 18.

Figure 3.—Restoration of the soft parts. The hard skeleton parts are entirely omitted. Only the end of one of the branches of a colony is represented, but this is typical of the structure of the whole. The upper surface of the branch is supposed to be cut away to show the connection of the gastrozooids with the cœnosarcal tubes. The outermost of the latter are studded with the defensive zooids. The whole is much magnified, the actual size of the branches being represented in figures 1 and 2.

Figure 4.—Represents a longitudinal section of a small portion of a branch to show the connection of a polype (retracted) with the cœnosarcal tubes. In the figure the polype is connected with three of these. (A) The perisarc walls are shown, and the thin external layer forming at the mouth of the hydrotheca an operculum P. Outline drawn with the camera under Zeiss A. oc. 2.

Figure 5.—Transverse section of a small portion of the outermost part of a branch to show a defensive polype, connected with one of the outer cœnosarcal tubes, which is connected again with a deeper lying one. The defensive polype is enclosed by the nematophore. E. is one of the most external tubes, the outer wall of which is formed of the thin layer (P.) of perisarc, on which lies an accumulation of foreign substances, spicules, &c. Outline drawn with camera under Zeiss A. oc 2.

Plate 19.

Figure 11.—A small branch much enlarged showing the skeleton only, the soft parts having been dissolved in potash. The hydrothecæ are shown arranged spirally and projecting with circular margins slightly from the surface. The network of chitinous tubes is seen to represent somewhat in appearance the clathrate horny skeleton of certain sponges. The somewhat prominent lines on the surface corres-

pond to the dark curving ones in figure 6. The thin external layer with the nematophores is only shown at the edges, in reality it covers the whole surface. Letters as before. x 50.

Figure 12.—A diagrammatic drawing to show the relationship of the hard and soft parts as seen at the external part of a longitudinal section of a branch. A gastrozooid is shown partially expanded. Hy. the walls of the hydrotheca. C. cœnosarcal tube. Ma. protective zooid arising from the outermost cœnosarcal tube. P. the thin external layer of perisarc. P′. the continuation of the latter to form a collar beyond the opening of the hydrotheca. P″. the nematophore. T. tentacle.

Figure 13.—A semi-diagrammatic drawing of a hydrotheca as seen in a thick transverse section of a branch very much enlarged. The walls of the hydrotheca are supported by numerous extensions of the perisarcal network, and the openings into the internal-lying end of the hydrotheca are shown. The perisarc tubes have branched and anastamosed to such an extent that their walls form a network, and the tubular structure is not so evident as it is in the more deeply lying parts. Letters as before.

Figure 14.—The basal part of a gastrozooid cut obliquely to show the strong band of muscular fibres derived from the ectoderm together with the thick layer of mesoglœa. *Ect.* ectoderm. *End.* large granular endoderm cells. *M.* thick mesoglœa layer. *Mus.* muscle fibres, some in connection with the ectoderm cells, from the basis of which they arise, others cut at a deeper level, at which their connection with ectoderm cells is not seen. Possibly some have lost their connection with ectoderm cells. Drawn under Zeiss F. oc. 2.

Figure 15.—A defensive zooid highly magnified. It consists of a stalk and head. The former is in connection with a cœnosarcal tube one wall of which, as seen in longitudinal section is shown. The centre of the stalk is solid and continuous with the endoderm, though no cellular structure can be determined. Outside this is a thin layer of ectoderm in which nuclei are scattered. The head consists of nematocysts at the bases of which remnants of the cells in which they have been formed can be seen with their nuclei. *Ect.* ectoderm. *End.* endoderm. *M.* mesoglœa. *N.* nematocyst. Drawn under Zeiss apo. 4.0 mm. apert. 0.95 oc. 12.

Figure 16.—The collar-like operculum surrounding the margin of a hydrotheca seen from above. The collar is thrown into folds. Drawn under Zeiss F. oc. 2.

PLATE 20.

Figure 6.—A terminal branch, much enlarged to show the circular openings of the hydrothecæ, within which the polypes are withdrawn, and also the general spiral arrangement of the hydrothecæ. The surface is covered with tortuous grooves,

bounded by dark lines, indicating the edges of the perisarc, and is studded with nematophores seen at the edges of the branch. Hy. Hydrothecæ. P. nematophores.

Figure 7.—A longitudinal section of a small branch, showing the skeleton. The tubes of which the branch is composed are seen to be very irregular, but to run, especially towards the central part, in a direction generally parallel to the length of the branch. *E.* spaces or grooves, immediately beneath the thin external layer. *Hy.* hydrothecæ. *P.* thin external layer of perisarc. *P'.* the continuation of *P.* to form an operculum at the mouth of the hydrothecæ. *P''.* the nematophores. x 35.

Figure 8.—A transverse section of a small branch, to show the tubes of which it is composed. The tubes vary in size, and open into one another. The outer ones are incomplete externally, forming grooves, the lips of which are usually touched by the thin external layer of perisarc. Two hydrothecæ are cut through. The perisarc is thicker towards the outer than in the inner part of the branch. Letters as in Fig. 7, x 70.

Figure 9.—A small portion of the external part of a branch very much enlarged to show the roughly concentric layers of which the perisarc is formed. Letters as in Fig. 7.

Figure 10.—Small portion of a cœnosarcal tube with the perisarc walls from the interior of a branch. *Ect.* the ectoderm in which the outline of the cells cannot be clearly distinguished, and which varies in thickness in various parts coming in contact, in certain places, with the perisarc walls. *End.* the unilaminar endoderm, the cells of which are larger than those of the ectoderm. *x.* globular structures of unknown significance containing darkly staining parts which lie apparently within the cavity of the tube. Drawn under Zeiss F. oc. 2.

Plates 21, 22, 23 refer to *Plumularia procumbens.*

Plate 21.

Figure 17.—Restoration of the soft parts only of *Plumularia procumbens.* The polysiphonic stem is shown in section with the transverse connections between the various tubes which compose it. Down the centre runs the main tube from which arise all the lateral branches—pinnæ and hydrocladia—which are in connection with a varying number of the surrounding tubes. The most external ones give off numerous machopolypes, and on the pinnæ are shown the groups of polypes, each consisting of one gastrozooid and three machopolypes. One blastostyle is shown with a gonophore, arising from the angle between a pinnule and the main stem of the pinna. x 30.

Figure 18.—Longitudinal section of a male gonangium with its contained blastostyle and gonophore. In the centre of the gonophore lies the manubrium. *Bl.*

blastostyle. *D.* swollen distal, end of blastostyle. *Sp.* sperm. *G.* walls of gonotheca.

Figure 19.—Transverse section of a male gonangium and gonophore. On the left side between the gonophore and the wall are seen traces of the much compressed blastostyle. *End.* endoderm of manubrium. *Ect.* ectoderm outside sperm cells (*sp.*)

PLATE 22.

Figure 20.—Portion of a colony of *Plumularia procumbens* showing the polysiphonic stem and the pinnæ arising irregularly from this, x $1\frac{1}{2}$.

Figure 21.—Much enlarged portion of a pinnule or hydrocladium to show the alternate longer and shorter joints. The latter bears no hydrotheca or nematophores ; the former bears a hydrotheca with the nematophores at the level of the mouth of the former, and one in the median line below. The thickenings in the walls of the pinnule are shown in their positions and the two nematophores in the axil between the pinnule and the main stem of the pinna, and at A, the conical structure opening to the exterior. N^1. upper pair of nematophores. N^2. lower median nematophores. N^3. nematophores in the axil of the pinnule and pinna stem. A. conical process in the axil leading from the interior of the pinna to the exterior.

Figure 22.—Much enlarged view of a nematophore seen in optical section, and showing the two chambers.

Figure 23.—Much enlarged view of a male gonangium.

Figure 24.—Semi-diagrammatic drawing of a longitudinal section of the polysiphonic stem of the same to show the relationship of the hard and soft parts and the distinctness of the central tube with its walls slightly yellower than those of the surrounding tubes. C. central tube. H. central stem of pinna. H′. hydrocladia. L. lateral tubes. N. nematophores. T. transverse connections uniting the various tubes. x 30.

PLATE 23.

Figure 25.—Much enlarged view of the termination of a polysiphonic stem, showing the numerous nematophores on the stem and the pinnæ &c., arising irregularly. The basal parts of the pinnæ are strengthened by the formation of a thick perisarc wall continuous with that of the tubes forming the stem. x 20.

Figure 26.—A highly magnified portion of a pinna.

Figures 27 and 28.—Transverse sections of the polysiphonic stem to show the component tubes—skeleton only—with the large central one, from which in figure 28 a pinna is arising. The external tubes are studded with nematophores.

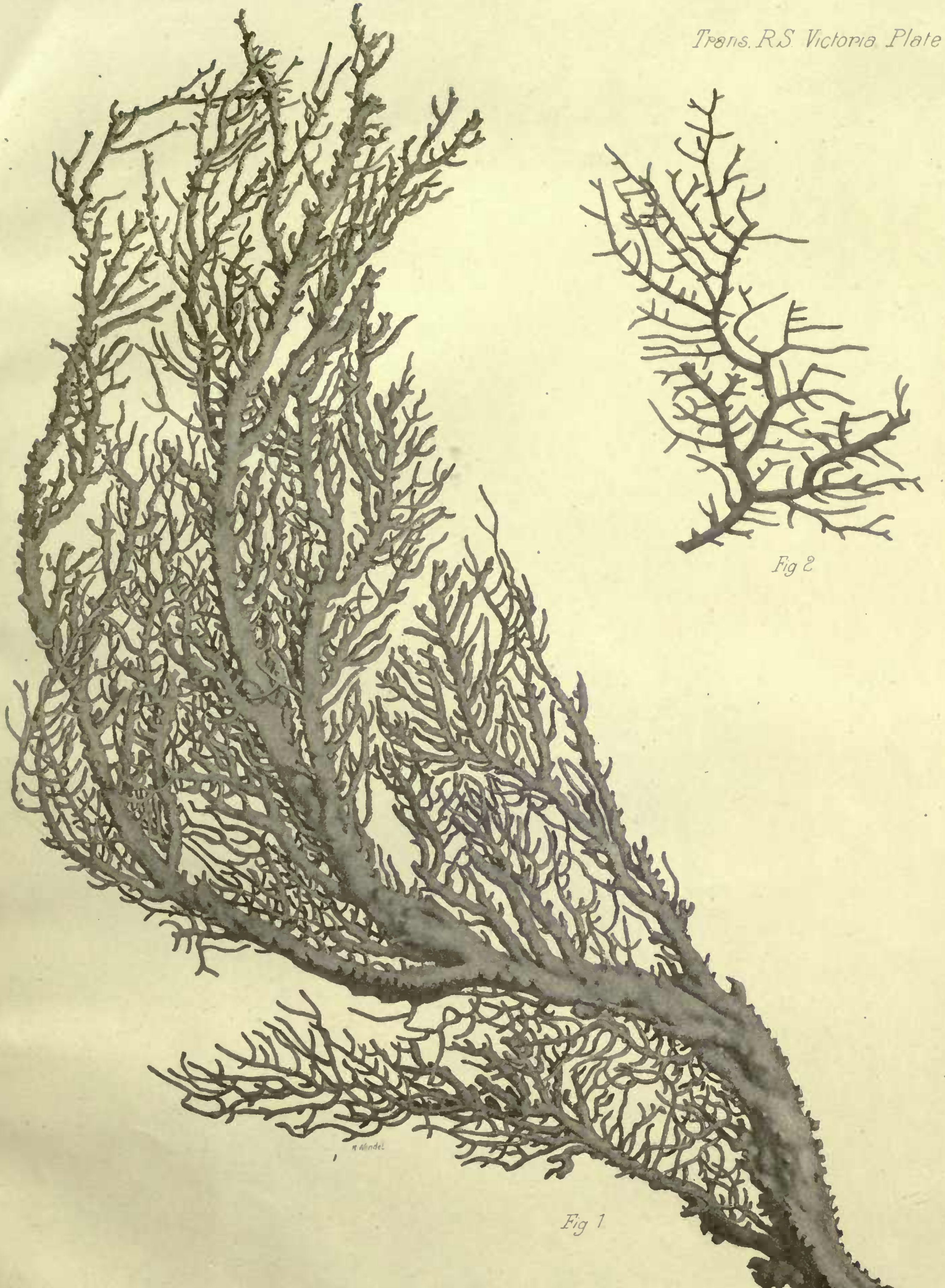

Fig 2

Fig 1

C. Troedel & Co Lith. Melb.

CLATHROZOON WILSONI.

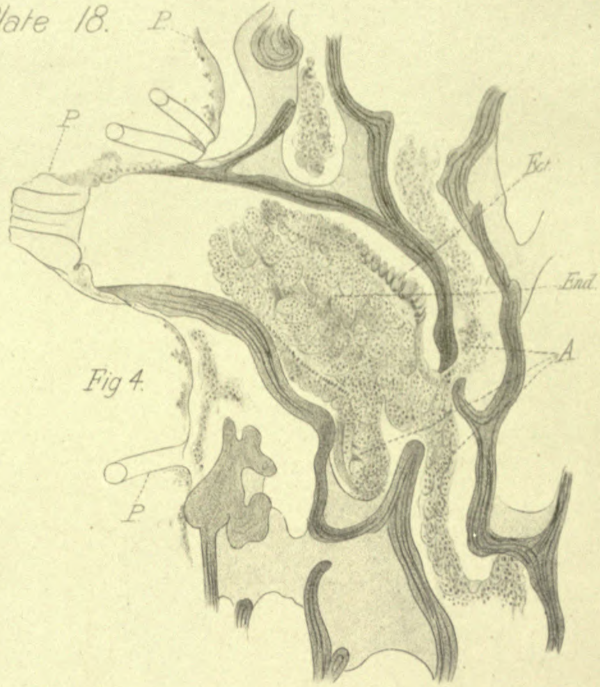

Fig 4.

Fig 3.

Fig 5.

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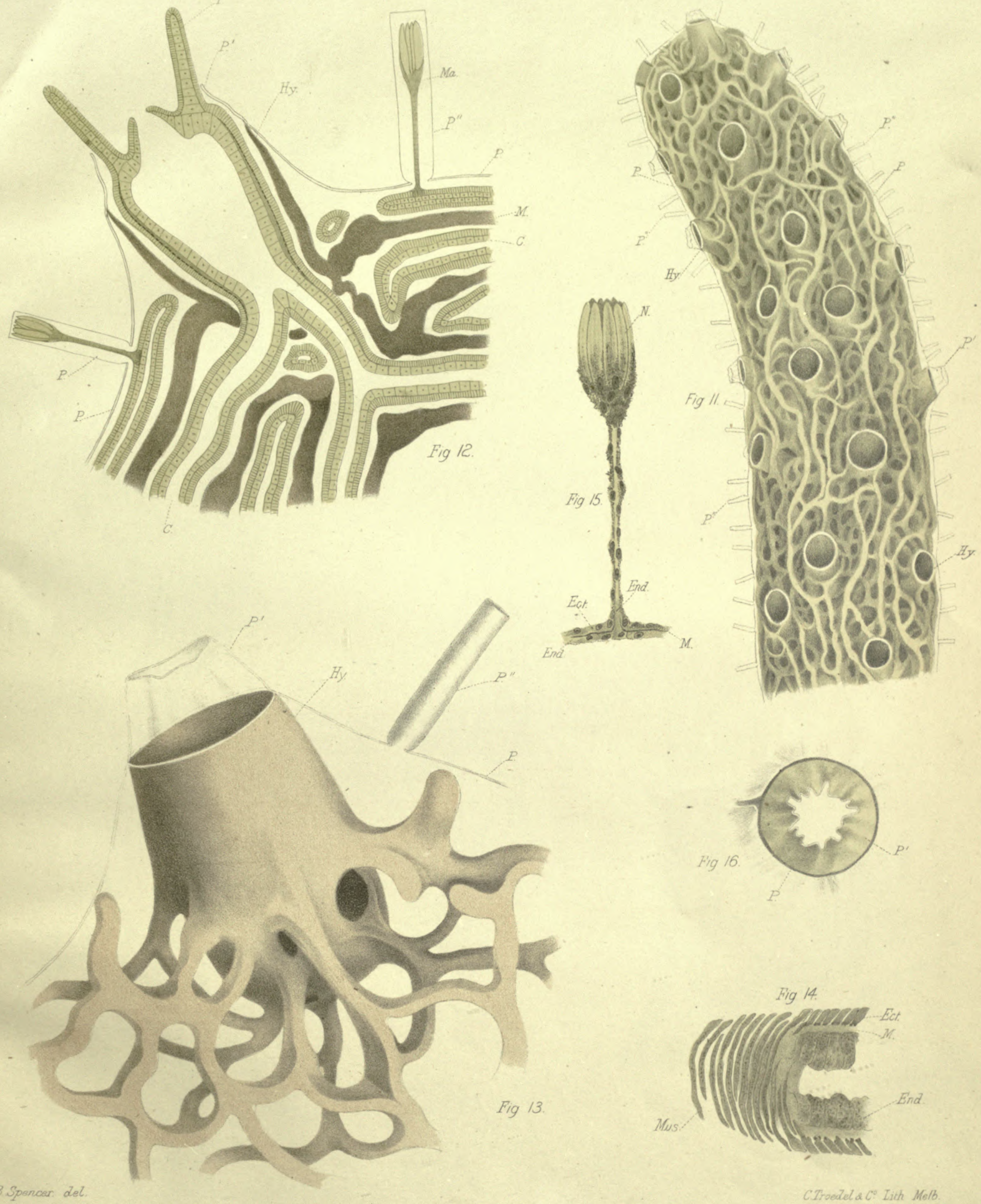

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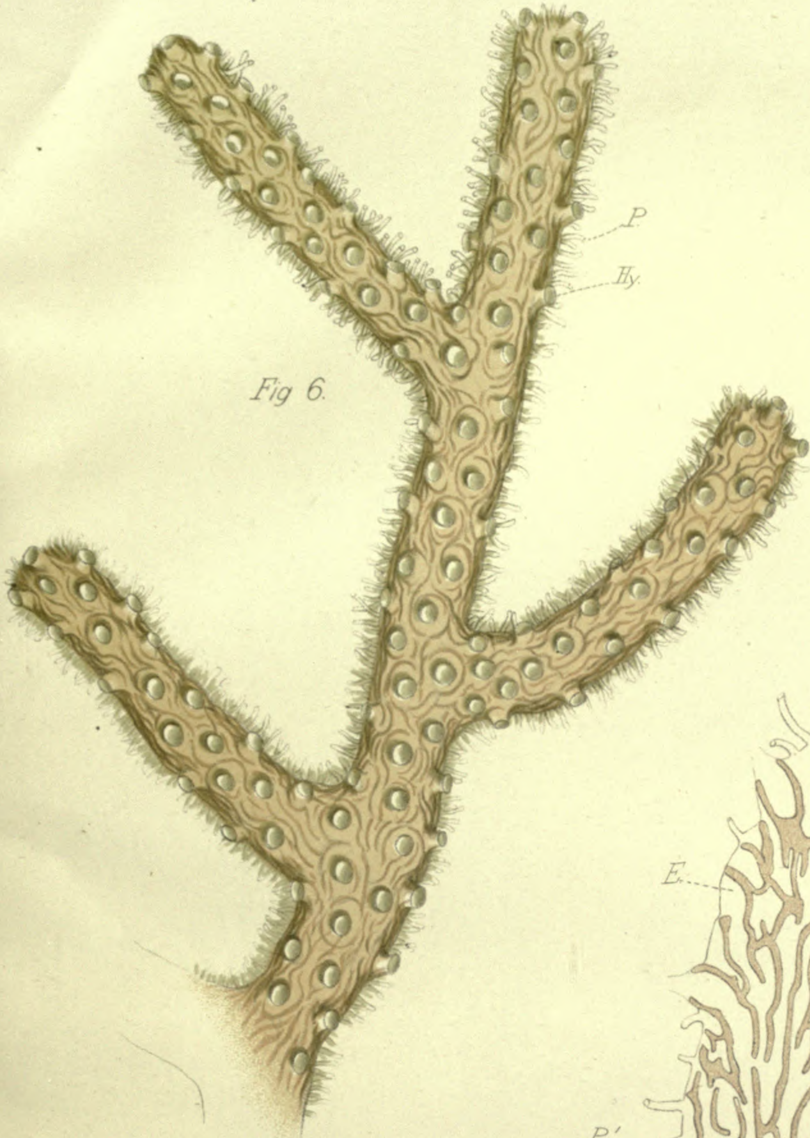
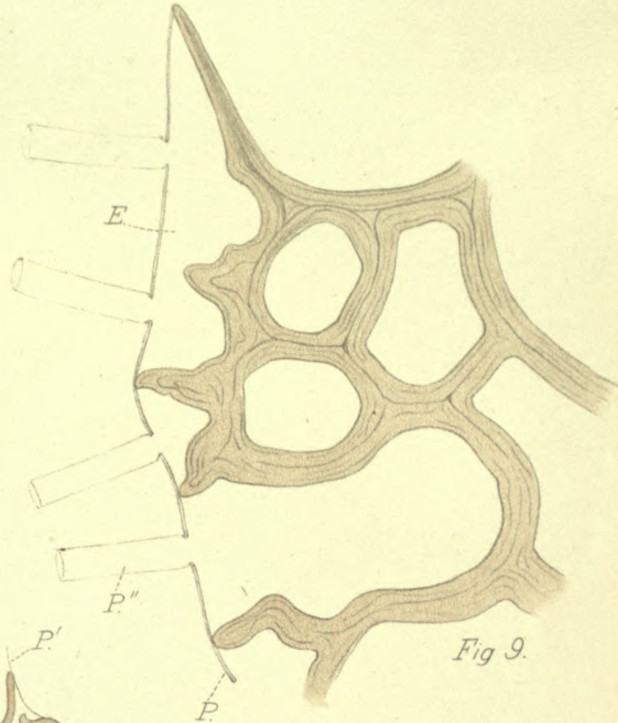


Fig 6.



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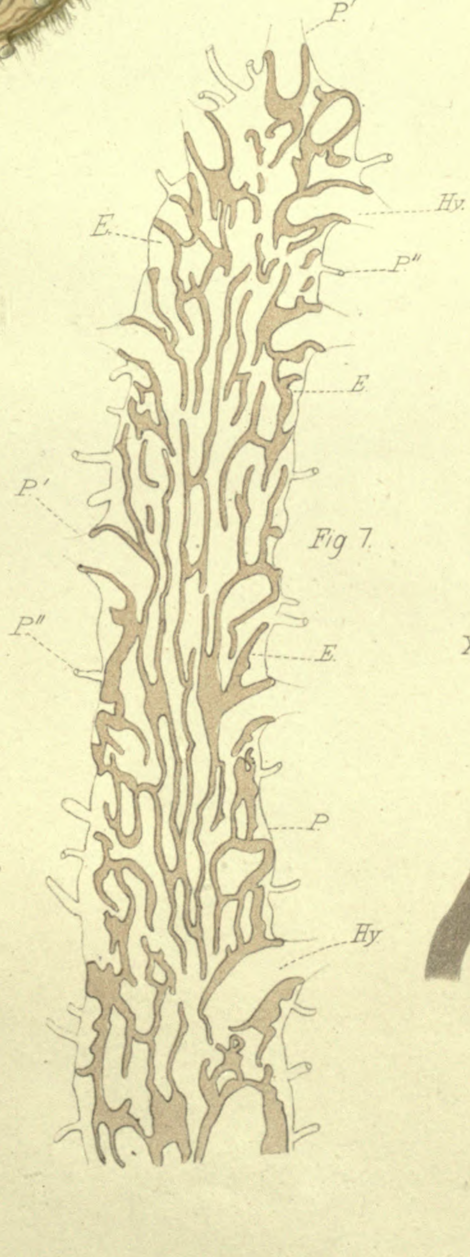

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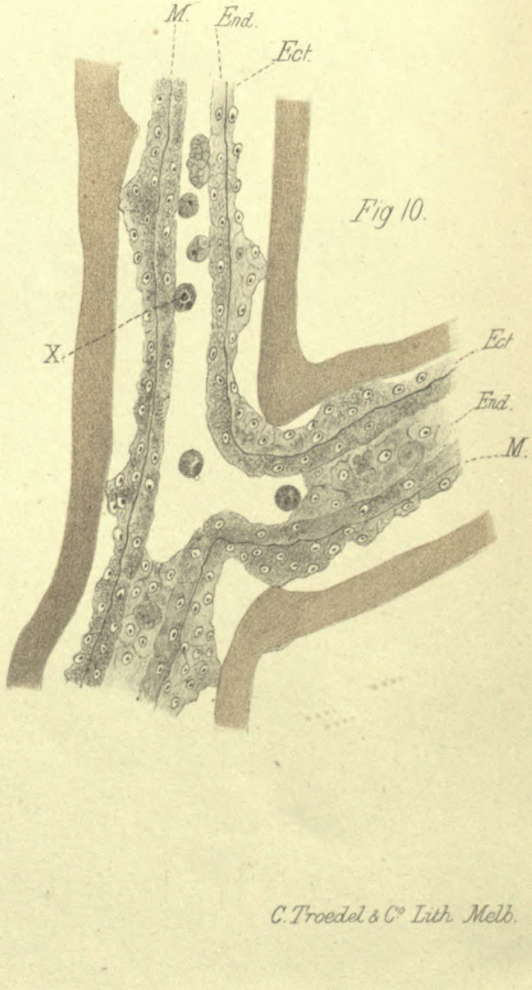

Fig 10.

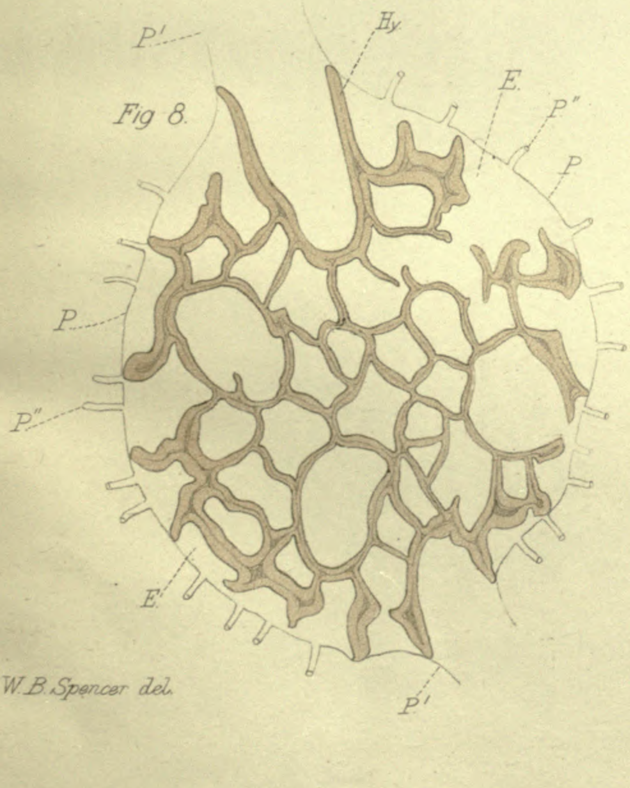

Fig 8.

W. B. Spencer del. C. Troedel & Co. Lith. Melb.

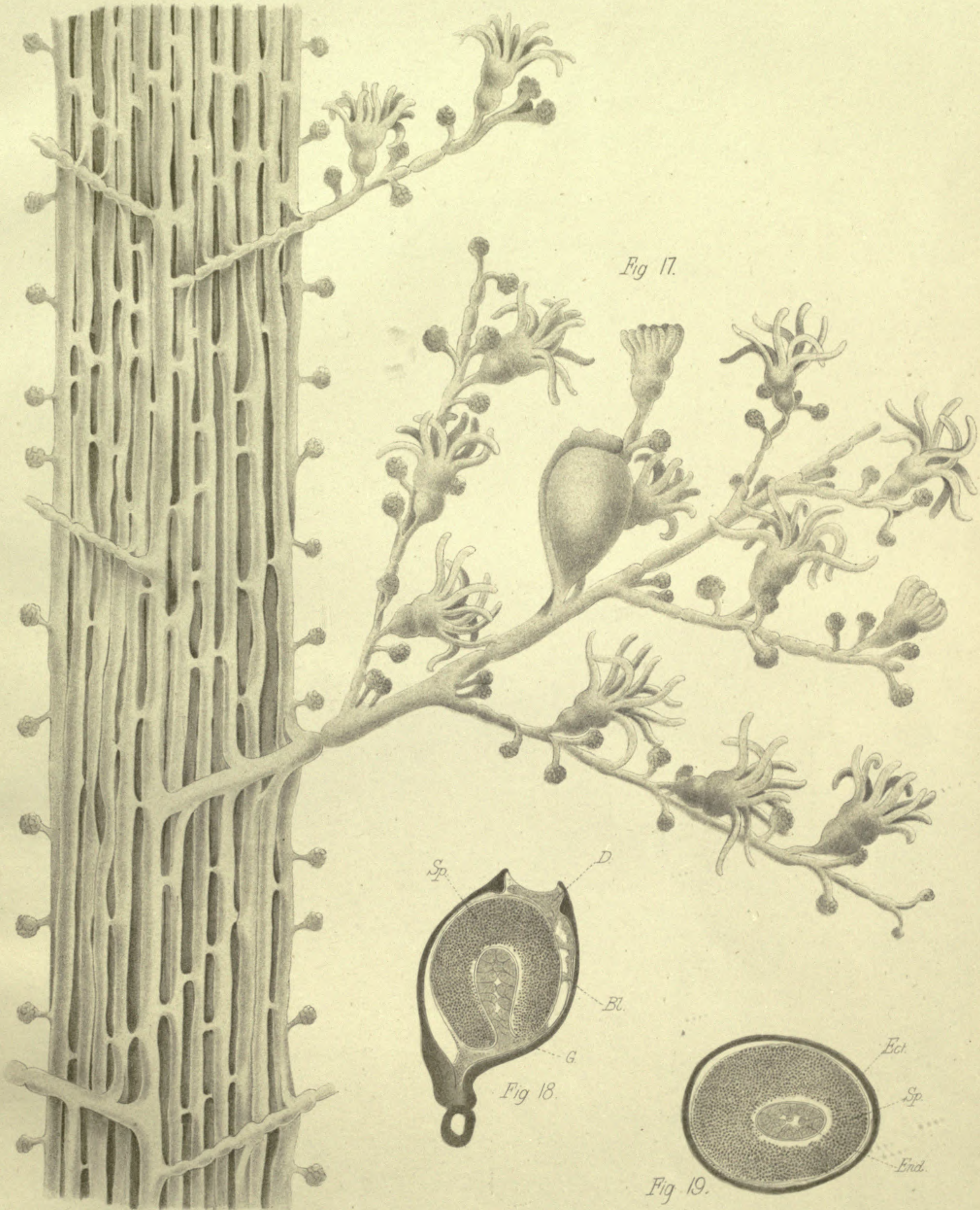

Fig 17.

Fig 18.

Fig 19.

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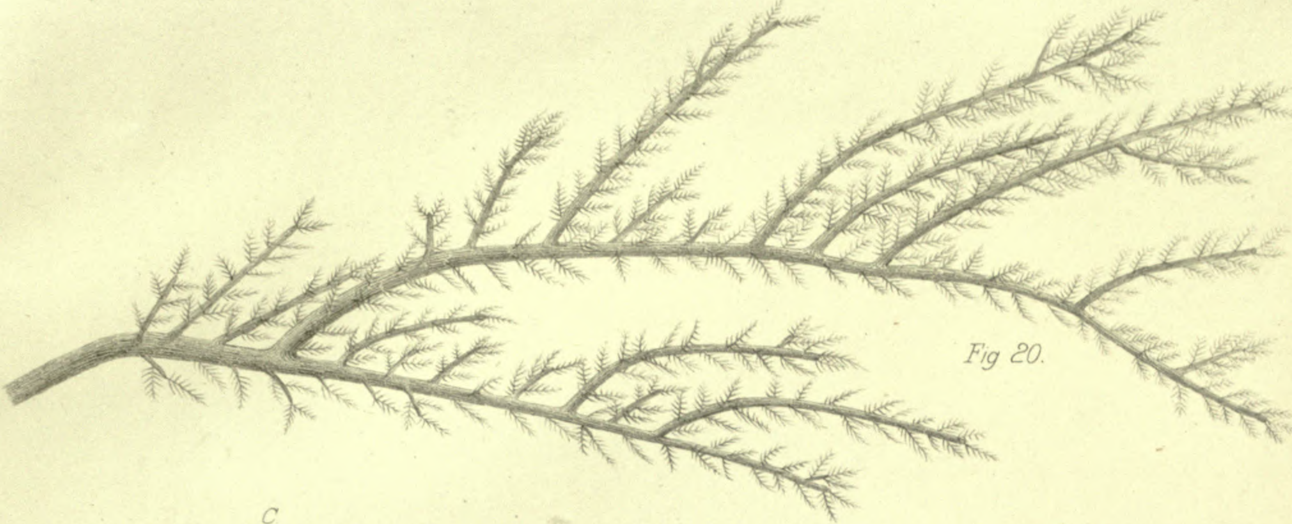

Fig 20.

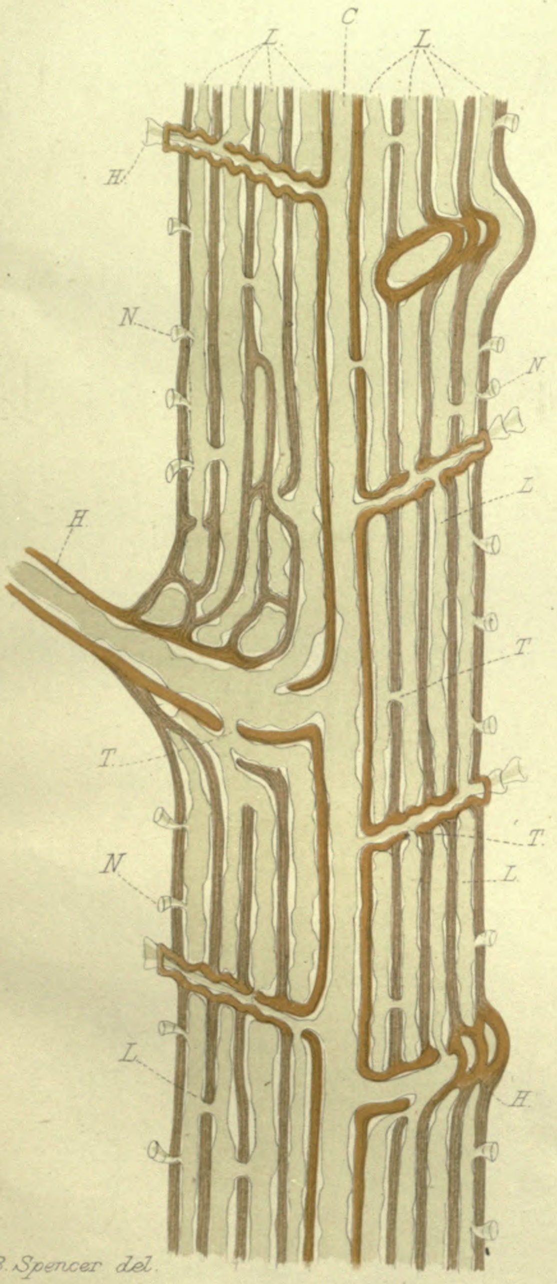

Fig 24.

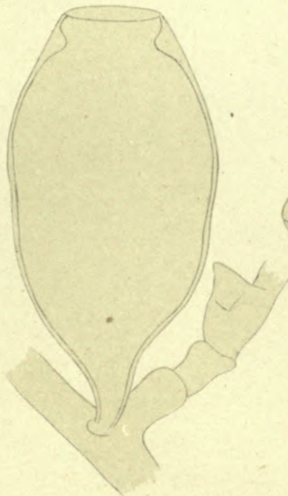

Fig 23.

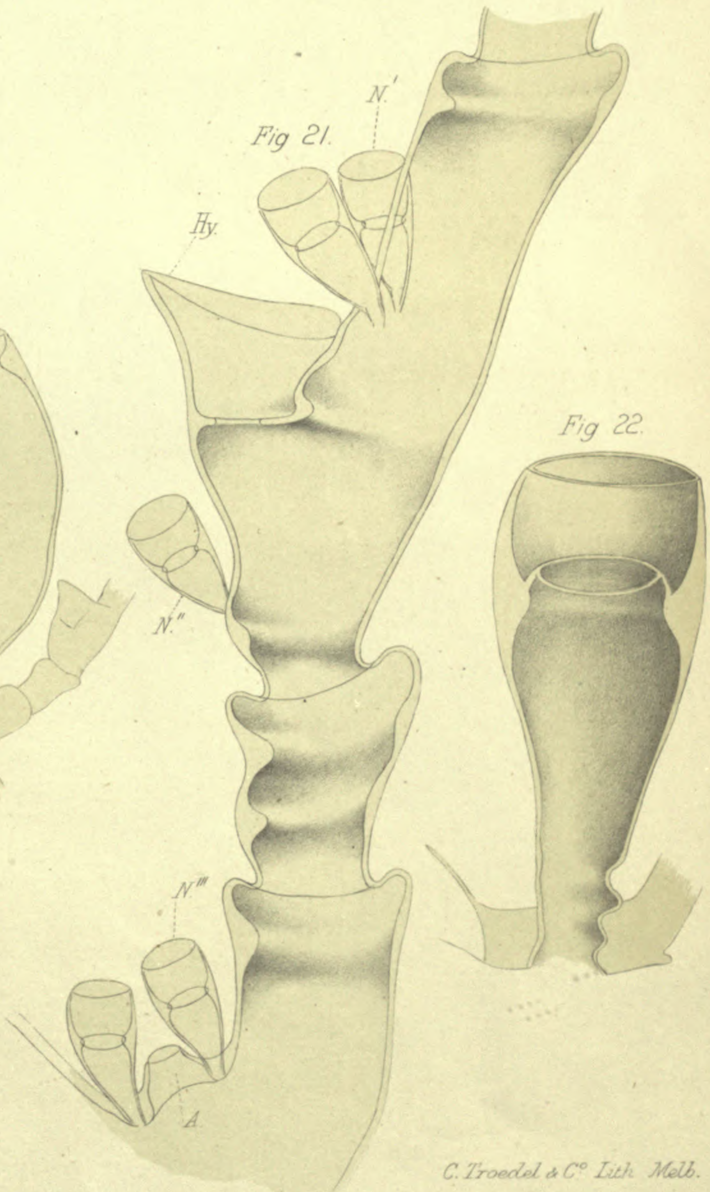

Fig 21.

Fig 22.

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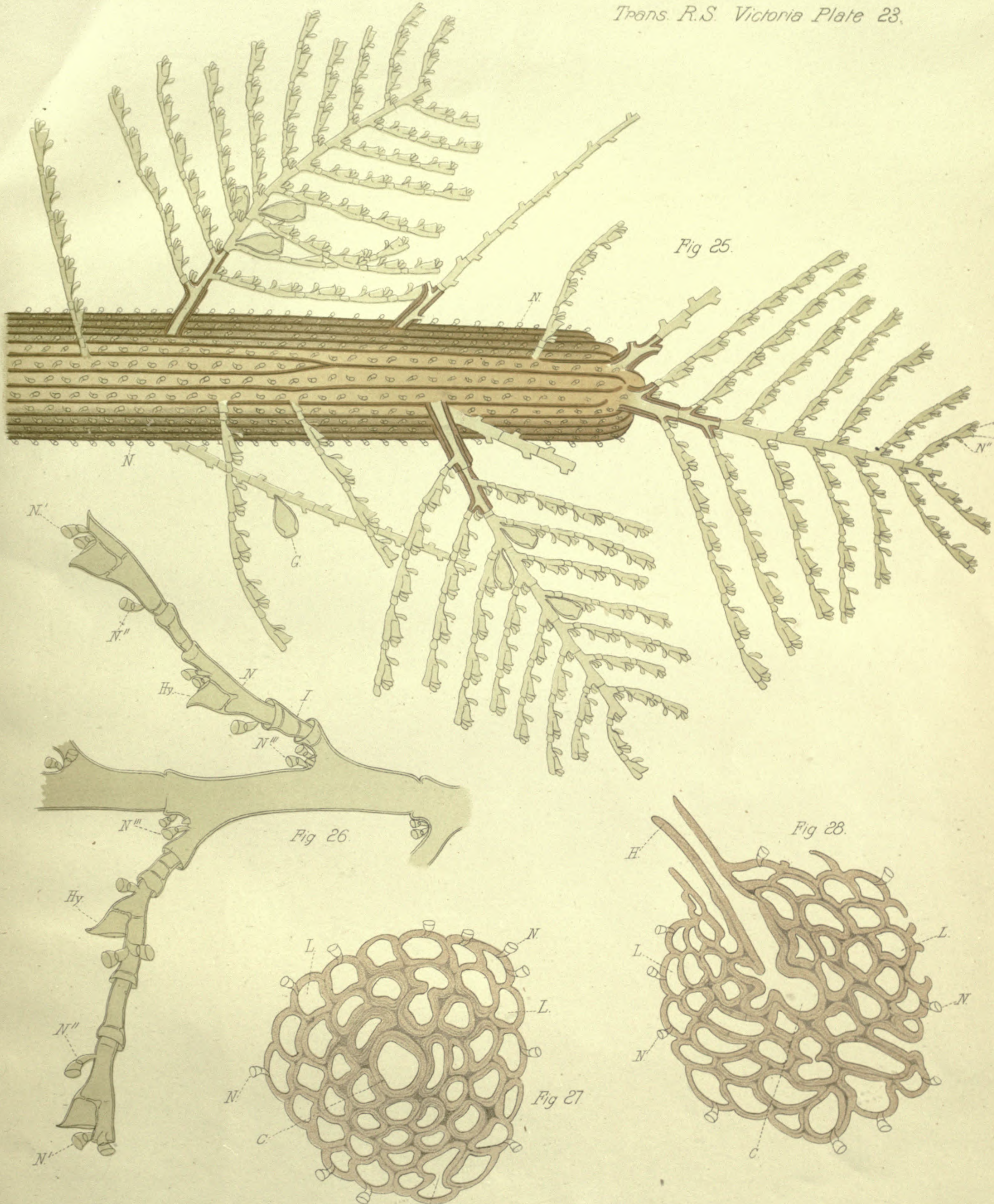

Fig 25.

Fig 26.

Fig 27.

Fig 28.

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ON THE

STRUCTURE OF CERATELLA FUSCA

(GRAY).

By W. Baldwin Spencer, M.A.,

Professor of Biology in the University of Melbourne.

Reprinted from the Transactions of the Royal Society of Victoria for 1891.

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ON THE STRUCTURE OF CERATELLA FUSCA (GRAY),

BY

W. BALDWIN SPENCER, M.A.,

Professor of Biology, in the University of Melbourne.

ARTICLE II.—On the Structure of Ceratella fusca (Gray), by W. Baldwin Spencer, M.A., Professor of Biology in the University of Melbourne. (With Plates 2, 3, and 3a.)

(Read Thursday, June 11th, 1891.)

I have to thank Dr. Ramsay and the Trustees of the Australian Museum, Sydney, for the opportunity of examining the structure of this interesting hydroid form. The specimens examined came from Bondi on the New South Wales coast and from Lord Howe Island, where they were collected by Mr. Whitelegge of the Australian Museum, whom I have to thank for kind assistance. The Lord Howe Island specimen had the zooids beautifully expanded.

Dr. Gray* was the first to describe and figure Ceratella and the closely allied genus Dehitella from specimens in the British Museum. He had dried specimens only at his disposal and his description necessarily refers only to the hard parts and these having the form of a horny network somewhat resembling in general appearance the skeleton of a horny sponge, led him to place the two forms provisionally amongst the sponges. For their reception he constituted the family *Ceratelladæ*. Five years later Mr. H. J. Carter† published a paper entitled "Transformation of an Entire Shell into Chitinous Structure by the Polype Hydractinia, with short Descriptions of the Polypodoms of five other Species." In this he refers to *Ceratella fusca* and *Dehitella atrorubeus* and describes two new forms belonging to the former genus under the names of *C. procumbens* and *C. spinosa.* Both of these came from South Africa the former from the Cape of Good Hope and Natal the latter from Natal. In the same paper he describes a new genus Chitina with a single species *C. ericopsis* which came from New Zealand. Reference to these will again be made after the anatomy of *Ceratella fusca* has been described, meanwhile it is sufficient to note that Mr. Carter's investigations of a species of Hydractinia (*H. levispina*) with a skeleton composed of a horny network which incrusts and eats its way into univalve shells led him to re-examine the two forms placed by Dr. Gray in the family Ceratelladæ and in consequence of his finding undoubted traces of thread-cells in the dried specimens both of these and of the two new species of Ceratella mentioned above, he rightly recognised them as belonging to the

* Proc. Zool. Soc., Nov., 1868.

† An. and Mag. Nat. Hist., Jan., 1873.

Hydroidea and not to the sponges in which group Dr. Gray had provisionally placed them. At the same time it may perhaps be well to note that the finding of thread-cells in dried specimens with a skeleton in the form of a horny network is not in itself absolute proof of their belonging to the Hydroidea inasmuch as at the present time sponges are known to exist the substance of which is pierced by hydroid growths so that it would be possible to find thread-cells in the dried skeletons of sponges. At the same time Mr. Carter was perfectly right, as events have proved, in removing the Ceratelladæ from the Porifera though the subsequent discovery by Mr. Bale of the nature of their soft parts has shown that they cannot be placed, where Mr. Carter put them, in the family Hydractiniidæ.

The next notice of these forms occurs in the Proceedings of the Linnean Society of New South Wales for 1886 (p. 575) when Mr. Brazier recorded the occurrence of *Ceratella fusca* from various localities near Sydney such as Bondi Bay and Coogee. In the Proceedings of the same Society for the year 1888 (p. 745) Mr. Bale for the first time gave some description of the soft parts and showed that the zooids were formed on a very different type from those of the Hydractiniidæ. The latter have a single circlet of filiform tentacles surrounding the hypostome whilst those of Ceratella are irregularly distributed over the body and are capitate. Mr. Bale accordingly removed Ceratella from its position amongst the Hydractiniidæ assigned to it by Mr. Carter and placed it in a distinct family to which he gave the name Ceratellidæ. He apparently overlooked the fact that Dr. Gray had already adopted the name of Ceratelladæ for the family including his two genera Ceratella and Dehitella, so that this name given in 1868 must now be retained. With a more abundant supply of material I have been enabled to work out the structure in greater detail than was possible to Mr. Bale to whom we owe the first description of the soft parts and the determination of the fact that Ceratella belongs to a family distinct from the Hydractiniidæ.

Description of the Structure of Ceratella fusca.

I have endeavoured so far as possible to give a complete account of the anatomy of both soft and hard parts the only figures yet published being those of the external form given by Dr. Gray* both of which suffice to clearly identify the genera.

Skeleton.

The colonies of Ceratella procured on the New South Wales coast measure from 1½—5 inches in height and are of a rich brown colour. The largest specimen which I have seen is the one procured by Mr. Gabriel which came from Flinders Island in Bass Straits where it had been washed ashore. The figure given by Dr. Gray

* *Loc. cit.*

represents fairly well the macroscopic characters of the skeleton but conveys the idea of one which has been much water-worn and has lost many of its smaller branches. The branching is much richer and closer than is represented by him and the projecting hydrophores are more distinct and regular. At the same time there is a certain amount of difference in the growth of various colonies some of which are more bushy in appearance than others. That secured by Mr. Gabriel has the branches more distinctly arranged in one place than is the case with the others. The whole colony may be described as follows:—The colony arises from a much-branching root-like base encrusting foreign objects. The root-branches unite to form a strong stem common to the colony which is flattened in the same plane as that in which the branches of the colony, generally, expand. The common stem may have the appearance of being formed of intertwined branches and from it arise irregularly larger or smaller branches the former being more or less flattened in the same plane with itself.

From the larger arise irregularly on either side smaller branches which again branch until a somewhat bush-like or fan-shaped colony is formed the whole being more or less flattened in the plane of the main stem. Except the main stem close to the root branches and the latter all the branches may bear bracket-like projections—the hydrophores—which are arranged in a roughly spiral manner and are especially abundant on the smaller branches except the growing ends which are somewhat swollen and flattened in a plane at right angles to that in which the branching of the colony takes place.

In addition to considerable variations in the general form of the colony some appear to have the hydrophores so arranged that they lie along the two opposite sides only of the branches whilst in others they are arranged all around. The more bush-like the growth is, to the greater extent does the latter obtain and *vice versa.* Usually there is only one main stem arising from the root-branches but at times one or more smaller ones may arise independently. (Fig. 1.)

The skeleton when examined by the lens has much the same appearance as that of Hydractinia and differs considerably from that of Clathrozoon and more still from that of the polysiphonic stem characteristic of certain species of Plumularia. It forms in the larger branches a meshwork of chitinous tissues so similar at first sight to that of certain horny sponges that as Mr. Bale says "a portion broken off and examined separately might well be mistaken for sponge tissues." This however is only true with certain limitations for, if the soft parts are present, the distinction between the two is readily seen as is also the case when the hydrophores are present. Apart from this also nothing comparable to the layer of cells secreting the sponge skeleton is present nor are the chitin fibres of the two similar in their minute structure.

The meshwork is extremely irregular in the larger branches as is shown in the sections represented in figs. 9 and 11. There seem to be two not clearly distinguishable portions present (1) large and strong fibres (2) smaller ones which form connecting bars and often have the appearance of thin web-like plates which are especially well developed on the hydrophores. Fig. 5 represents a medium-sized branch, from which the soft parts have been removed by potash, seen by reflected light. At times the fibres seem to run for some distance parallel to the long axis of the branch though this is much more strongly marked in some branches than in the one figured. There are no definite hydrothecæ present within which the zooids can be completely retracted but the branches are studded sometimes only at the sides sometimes all over with little bracket-like projections which give a characteristic serrate appearance to the branches, very different however from that which is produced by the hydrothecæ of the Sertularians. Mr. Bale has aptly suggested that the term "*hydrophores*" (originally applied by Allman to the calyces of Halecium) should be used to describe these structures which form merely supports for the hydroid zooids. Each one may perhaps be best likened to a very concave scallop shell with ribs formed by the strong fibres continuous with those of the branch whilst the spaces between them are filled up by a thin fenestrated web of chitin. In some hydrophores the ribs are more strongly marked than in others and project as small points around the margin. (Figs. 5 and 6.) The growing ends of the smaller branches usually contain two or three longitudinal fibres connected by transverse bars, often somewhat web-like, and each of these growing ends is clearly distinguishable (1) by its being flattened in a plane at right angles to that in which general growth takes place and (2) by the entire absence of hydrophores and zooids. It may be added that the longitudinal arrangement of the fibres in the branches is more clearly noticeable in specimens with the soft parts present than in those in which the latter are absent since the soft parts conceal from view largely the connecting and the deeper-lying fibres and thus prevent to a large extent the network structure from being seen. The whole skeleton also in living specimens is completely enclosed by the soft parts though only a thin layer of tissue is present over the external surface. (Figs. 9, 10 and 11 E.) There is no protective covering for the reproductive structures.

Soft Parts.

The structure of these has, as yet, been only briefly described once and that by Mr. Bale, whose short account refers only to the external form of the hydroid zooids. He pointed out, as stated before, that these possessed irregularly scattered capitate tentacles and that hence they differed considerably from those of Hydractinia.

Amongst the specimens from the Australian Museum is one collected by Mr. Whitelegge on Lord Howe Island with the zooids fully expanded and others with the soft parts well preserved.

(1). *Hydroid zooids* (Figs. 2, 4, 6, 7, 9, 13).—These may be found on all the branches, large and small except at the growing ends. Often also they are absent on the larger main branches and are always fewer in number on these than on the smaller ones (Fig. 4). Each zooid, in a well preserved spirit specimen, reaches a length of about 1·4 m.m. and in the general form of the body resembles, as Mr. Bale says, those of Coryne. The body (Figs. 4 and 6) is somewhat elongate with a terminal almost conical portion, at the apex of which lies the mouth opening. The basal portion which is seated upon the hydrophore is broad, this is followed by a slightly contracted portion, then comes a slightly swollen part which gradually diminishes in size towards the mouth end. Over the surface are scattered irregularly the capitate tentacles from 10-14 or perhaps even more in number (Figs. 4 and 6), and one or two of these are frequently placed close to or upon the basal region.

The minute structure is generally that which is typical of hydroid forms and is represented in Figs. 2 and 7. The ectoderm (*Ect.*) is unilaminar over the general surface the cells being in close apposition each with a large nucleus and except in the capitate ends of the tentacles there are no thread cells present. At the ends of the tentacles the ectoderm is swollen out and apparently forms a mass of cells in which large nematocysts are present with barbed threads (Fig. 7). The nematocysts here and elsewhere seem to be all of the one size. The ectoderm lies on a thin layer of mesogloea scarcely visible in extended zooids but more prominent in retracted ones. There cannot be detected any fibrous muscular elements such as form so distinct a feature around the basal region of the zooids in, for example, Clathrozoon. The endoderm consists of large vacuolate cells each one subtending the base of, as a general rule, at least three ectoderm cells. The protoplasm appears to be always concentrated at the inner ends where the nuclei are placed and where in preserved specimens the cell outlines are completely lost. In zooids which are feeding (Fig. 7) this inner end of the cell is filled with minute food particles the digestion being evidently, in part at least, intracellular.

The ectoderm is continuous at the base with the layer which covers externally the whole colony whilst the endoderm is continuous with that of two or more of the cœnosarc tubes.

(2.) *Gonophores.*—I have only been able so far to find the male gonophores which are present on three colonies secured at Coogee on the New South Wales coast. Each of these colonies carries numbers of minute somewhat pear-shaped structures which are only from one-third to one-quarter of the length of the hydroid zooids and which are seen when rendered transparent or cut into sections to be medusoid in nature.

These gonophores arise directly from the cœnosarc and are not carried by modified zooids or blastostyles.

They may be very numerous indeed especially on the medium-sized branches where their number in one specimen far exceeds that of the hydroid zooids. Two are represented as seen by reflected light in figure 6 and in all specimens examined the gonophores are at the same stage of development. I have been unable to detect any indication of the formation of reproductive elements in the hydrophyton.

The gonophores much resemble in structure those figured by Weismann* in *Pennaria cavolina* or *Cladocoryne floccosa.* In essential structure the transverse section of the gonophore of the former is identical with that of a similar section of a Ceratella gonophore as shown in figure 8. The longitudinal section again of the gonophore of Cladocoryne or of Pennaria as figured by Weismann agrees almost precisely with that of Ceratella represented in figure 12. In the latter the manubrium is well developed and surrounding this lie the reproductive elements which in longitudinal section (Fig. 12) form a horseshoe-shaped mass and in transverse section a ring. External to the latter is a thin layer of ectoderm (ect.') which comes in contact with the external layer of ectoderm (*ect.*) at the part corresponding to the mouth of the medusa bell where the former layer dips inwards. (Fig. 12, *M.*) This layer must correspond to the sub-umbrella ectoderm of the medusa and the special point mentioned indicates also the position at which, in development, the "glockenkern" of Weismann grew in by proliferation of the ectoderm cells. I have been unable to find any gonophore younger than the stage figured though many have been cut in section, the manubrium being in every case well developed.

Between the two layers of ectoderm lies the endoderm with four radial canals seen clearly in transverse sections (Fig. 8) whilst in longitudinal sections (Fig. 12) the indication of a ring-shaped space around the distal end can always be detected.

Each gonophore may be connected with more than one of the cœnosarc tubes and its ectoderm is continuous with that which covers the colony externally.

(3.) *The Hydrophyton.*—This may be divided into two parts (1) the external layer common to the whole colony and (2) the branching network of tubes.

The external layer is formed entirely of ectoderm cells (Figs. 3 and 12) and is only one cell thick though it may come into contact with the ectoderm of the tubes lying immediately beneath it. It is especially well marked in the younger branches and may be worn away to a greater or less extent in older ones though typically it forms a covering for the whole of the colony (Figs. 9 and 13). It is directly

* Die Entstehung der sexualzellen bei den Hydromedusen. Pl. XVII., Figs. 1-5 and Fig. 7; Pl. XVIII., Fig. 1.

continuous with the ectoderm of both the hydroid zooids and the gonophores, and has in many respects a close resemblance to the superficial layer of ectoderm as described and figured by Professor Moseley in Millepora.* In the latter the exact relationship of the superficial ectoderm to the zooids could not be ascertained but in Ceratella where the latter are not retracted into spaces within the skeleton its direct connection with the ectoderm of the zooid can easily be seen in sections. Figure 3 represents a small portion of the layer as seen under a high power. The outlines of cells cannot be definitely distinguished in the specimen in question though a somewhat light space with a fairly distinct outline surrounds the thread cells. The inner ends of the cells are in contact with the ectoderm of the tube beneath and the layer thins out just where it passes over the projecting point of a portion of the skeleton. In younger branches (Fig. 14) the cells of the layer are much more definite in form and outline being each cubical with a distinct nucleus whilst comparatively very few thread-cells are present.

This superficial layer is only known to exist in the Hydrocorallinæ, the Hydractiniidæ and, now, in the Ceratelladæ. In the last mentioned the soft parts of only *Ceratella fusca* are known as yet but the skeleton of Dehitella is so closely similar to that of the former that we may with much probability infer that a close agreement exists in the nature of their soft parts. The cœnosarc tubes form a richly branching network of tubes occupying all the spaces in the chitinous meshwork which forms the skeleton. In Figures 9 and 10 this is represented diagrammatically by the grey colour the former being a longitudinal and the latter a transverse section of a branch. Throughout the whole system the endoderm is never more than one cell thick whilst the ectoderm is very irregular. Very often the endoderm cannot be recognised or else it forms an indistinct layer which stains more darkly than the ectoderm and contains no space, a result probably due to the action of reagents. At other times (Figs. 3, 11, 12, and 14) a distinct tubular space can be distinguished. The number of tubes varies naturally according to the size of the branch. Figure 13 represents a longitudinal section through a portion of a small branch with a smaller offshoot which formed part of a specimen brought by Mr. Whitelegge from Lord Howe Island. The general appearance of a part of the same specimen viewed as a solid object is represented in Figure 4. This particular specimen has the branches much finer than those of the others and the skeleton and cœnosarc tubes somewhat more regular in arrangement, whilst the hydrophores are not very strongly developed. Up the small offshoot pass the main skeletal ribs united by cross bars which are thin and almost web-like and up the centre runs a single cœnosarc tube (*B*) which is connected with at least three of those in the larger branch. This tube consists of an internal layer of endoderm (Fig. 13 a, *end.*) and

* On the Structure of a Species of Millepora occurring at Tahiti, Society Islands. Phil. Trans. R.S. London, 1876, Vol. CLXVII., p. 117.

an irregular external layer of ectoderm (*ect.*) the former being continuous with that of the zooids. The whole is covered by a unilaminar ectoderm (*E*). A few thread cells are present. Up the layer branch the tubes run more regularly than usual and three or four may be traced for a considerable distance running parallel to its length but giving off lateral branches. In sections both transverse and longitudinal of Ceratella these connecting bars or webs crossed by cœnosarc tubes form a very characteristic feature (Figs. 11 and 13. *C*).

As stated above there is a strongly-marked difference between the endoderm and ectoderm. The former (Fig. 3) is regular and takes stain somewhat more readily than the latter, which is often very irregular and several cells thick, though most often the outlines of cells cannot be recognised, and a structure resembling a syncytium is formed. In the latter are found (1) nuclei, (2) thread cells, (3) bodies surrounded by a clear space and staining evenly and deeply (Fig. 3A). The thread cells are apparently confined to the ectoderm, though of this I cannot feel absolutely sure, and are found in great abundance in the inner parts of the branch whence they must migrate to the surface if they are to be of service to the colony. It is a somewhat curious fact that they are as a rule present in far greater numbers in the ectoderm of the cœnosarc tubes than in the most external layer. Figure 3 represents a small portion of the latter on a part of a colony where the gonophores were numerous and here thread cells were present in greater numbers than elsewhere. Of the nature of the third-named structures it is difficult to be certain but it is probable that they are ectoderm cells in which thread cells are being formed. There is at all events a curious agreement in appearance between them and the structures which Professor Moseley has described as developing thread cells in Millepora.* He says "the thread cell appears to be developed out of the nucleus of the ectodermal cell, the ectodermal cell becoming much enlarged and forming a wide chamber, in which the process of development takes place. The ovoid nucleus becomes enlarged together with the cell, but not at all in the same proportion the cell always appearing as a wide cavity around it. The nucleus as it enlarges has a rounded nucleolus developed at one end of it." The nucleolus has large granules developed within it, whilst the nucleus becomes finely granular. In the next stage one large coil of the thread appears in the nucleus."

The earlier stage seen in Millepora when the nucleus with nucleolus at one end of it lies in the cell which forms a clear cavity around it, corresponds exactly to that represented in figure 3A.c. in the case of Ceratella. Though a complete series of stages could not be obtained still those drawn in figure 3A. will serve to show that in all probability Ceratella resembles Millepora closely in the formation of thread cells. In figure 3A.*a.* the cell is small and the nucleus but little larger than that of an

* *Loc. cit.*, p. 129.

ordinary ectoderm cell though stained very deeply and having a homogeneous appearance; in *b.* the cell has increased in size, the nucleus is much larger, and has a clear space all around it between it and the cell wall; this is clearly marked in *c.* and *d.* where, in the former, a nucleolus is present and in the latter two darker thread-like lines possibly indications of the commencing formation of the thread; in *e.* what is evidently a very young thread cell is seen—it is somewhat darkly stained without a definite thick wall such as is seen clearly in later stages, and down the centre is a lighter line corresponding to the thicker attached part of the thread. It has also the shape of the thread cell but there is no trace of the clear space present in earlier stages, a certain amount of stained protoplasm being attached to it. In *f.* and *g.* two later stages are shown in which the thick cell wall is present and the coiled thread can be clearly seen. These thread cells evidently resemble closely in structure the three-barbed ones described by Professor Moseley in Millepora.

The only other point to notice in regard to the cœnosarc is the structure of the finer growing branches which are somewhat flattened out. A longitudinal section of one of these is represented in figure 14. Up the centre runs a cœnosarc tube with a large cavity and clearly-marked endoderm the ectoderm being as usual irregular. From this central tube short branches are given off (*D*) which run outwards towards the external layer with which, as at the point x, they may come into direct contact. At this point the cells of the two layers are well marked, and in all probability this shows us the earliest stage in the formation of a zooid. It has already been noted that the ectoderm of the latter is in direct connection not with that of the cœnosarc tubes but with the common external layer and this method of formation would explain this otherwise somewhat curious fact. The endodermal process grows out into a bud—the early stage of a zooid—carrying with it the external ectoderm layer which thus, as further growth takes place, naturally gives rise to that of the zooid itself. At the same time the cœnosarc tube branches as the stem increases in size and thus the zooid, if the branching be near the base of the latter, will become connected with two or more tubes.

Affinities of the Ceratelladæ.

When Dr. Gray first described these forms there were only two specimens available neither of which possessed the soft parts. The hard parts whilst agreeing in important points differed from each other sufficiently to be regarded by him as species of two distinct genera Ceratella and Dehitella.

Mr. Carter, with more material at his disposal, recognised the fact that they were hydroids and owing to similarities in their skeleton and that of Hydractinia placed them in the family Hydractiniidæ, thus abandoning Dr. Gray's family Ceratelladæ which had been created under the assumption that the two forms were allied to the sponges.

Undoubtedly in many respects Ceratella and Dehitella call to mind the Hydractiniidæ, but it is doubtful if even our knowledge were confined to that of the structure of the hard parts whether Mr. Carter's classification could be upheld. The one point of resemblance—and at first sight it is the most striking feature—is that the skeleton of both consists of a very irregular branching chitinous network. In the Hydractiniidæ however this has the form of an encrusting network with at most very feebly developed branches arising from it; these may more correctly be described as spines and they do not appear to carry any zooids. In the Ceratelladæ the whole colony consists of a much-branching structure arising from a comparatively small encrusting root-portion which may itself be made up of branches more or less entwined. In addition to this all the branches bear hydrophores or special developments of the network to support the hydroid zooids. These are never present in the Hydractiniidæ but always in the Ceratelladæ. Now that the soft parts are known there can be no doubt about separating the two families. The hydroid zooids are quite different those of Ceratella being provided as are those of Coryne with scattered capitate tentacles whilst there is no trace of protective zooids such as are present in Hydractinia and Podocoryne. In addition to this the gonophores arise directly from the cœnosarc and not from modified zooids. The most important points of agreement lie in (1) the existence in Hydractinia and Ceratella of a common external layer of cœnosarc which covers over the whole skeleton mass whether this be encrusting or branching in nature; (2) the presence in both of a network of cœnosarc tubes forming the hydrophyton. It may however be noted that in both these points we find a similar agreement to exist between Ceratella and, for example, Millepora amongst the Hydrocorallinæ as between the first named and Hydractinia.

The presence of this external layer which, in the Hydrocorallinæ and Ceratella at all events, consists simply of a layer of ectosarc is very difficult to explain. Professor Moseley* has represented it in Millepora as if it formed the outer layer of the surface cœnosarc tubes though even in this case it passes over all the parts (occupied by the calcareous skeleton) which on the surface lie between the tubes, and is very different in appearance and in the relative size of its cells from the ectoderm which elsewhere forms the outer wall of the tubes. In Ceratella it is perfectly independent of the tubes all of which have their own ectoderm covering though at the surface this comes in direct contact with the outer layer. I am not aware of any determination in Hydractinia of the exact relationship of this outer layer though very probably it will be found to agree with that of Ceratella.

It is not apparently connected in any special way with the formation of the chitinous network as this lies deep within the structure of the branch, and the only

* *Loc. cit.*, Pl. 3., Figs. 10 and 16.

purpose which it can apparently serve is that of a covering layer which prevents foreign objects from passing in between the meshes of the network and interfering with the general welfare of the colony. It is strange however to note, if this be its function, that most usually the internal cœnosarc contain a far greater number of thread cells than this external layer does in Ceratella.

In Millepora Professor Moseley was unable to determine its exact relationship to the zooids but in Ceratella by its means all the ectodermal structures lying on the external surface are brought into direct continuation with one another.

It may be noted in passing that though in the genus Clathrozoon* the branches of the colony are formed of a somewhat similar network of soft parts there is nothing present resembling this external layer the whole branch being in this instance covered with a thin protective perisarc.

Taking both the hard and soft parts we find the following points of agreement to exist between the Hydractiniidæ on the one hand and the Ceratelladæ on the other though it must be borne in mind that we only know as yet the structure of the soft parts in one member of the latter family.

(1.) The skeleton has the form of a branching chitinous network.

(2.) The hydrophyton consists of a network of freely branching and anastomosing cœnosarcal tubes.

(3.) The zooids arise directly from this network and no true hydrothecæ or gonothecæ are formed.

(4.) A common external layer is present enclosing the whole colony.

The two differ from one another in the following points :—

(1.) Hydractiniidæ form encrusting masses with at most spinulose branches arising from the surface which do not bear zooids. The Ceratelladæ always form freely branching masses either erect or procumbent: the basal part which serves to attach the colony being alone of an encrusting nature whilst even this has the form of intertwined branches.

(2.) The Ceratelladæ always possess hydrophores or special developments of the skeleton which serve as a support for the basis of the hydroid-zooids and nothing similar to which is found in the Hydractiniidæ.

(3.) The hydroid zooids Ceratelladæ possess scattered capitate tentacles those of the Hydractiniidæ being filiform and arranged in a single circle beneath the mouth.

* Trans. R.S., Victoria, 1890, p. 121. Pl. 18, Fig. 3; Pl. 19, Fig. 12.

(4.) The gonophores of the Ceratelladæ arise directly from the cœnosarc and are not developed on special zooids as in the case of the Hydractiniidæ.

Whilst the points of agreement detailed above serve to show a general resemblance between the members of the two groups those of difference are of sufficient importance to justify their separation into two distinct families.

As stated previously Dr. Gray's name Ceratelladæ will be retained and the following gives the characters of the family (modified from Dr. Gray's and Messrs. Carter and Bale's descriptions) and the list and characters of the genera and species yet known.

Family *Ceratelladæ* (Gray, Proc. Zool. Soc., 1868, p. 575).

Forming branching colonies. Skeleton in the form of a chitinous network with slight bracket-like or tubular projections (hydrophores) serving as a support for the bases of the gastrozooids.

Hydrophyton a network of branching anastomosing tubes the whole enclosed by a common ectoderm layer.

Gastrozooids naked.

Gonophores medusoid : fixed and arising directing from the hydrophyton.

Genus. Dehitella. (Gray.)

Colony dichotomously branched, expanded growing in a large tuft from a broad creeping base. Stem cylindrical, smooth; branches tapering and cylindrical. Hydrophores slightly tubular and on the smaller branches divergent nearly at right angles from the stem.

(1.) *Dehitella atrorubens.* (Gray.)

The description of the species is the same as that of the genus. It is known at present simply from that given by Dr. Gray* who states that the genus " is distinguishable from Ceratella by the greater thickness and cylindrical form of the stem, by the more tufted and irregular manner of growth and by the tufts of spicules (oscules or cells) being more abundant and equally dispersed on all sides of the branches and branchlets." The " oscules or cells " of Dr. Gray must be the structures which, following Mr. Bale, have been described above as " hydrophores."

Locality.—Delagoa Bay, Africa.

* Proc. Zool. Soc. 1868, p. 579. Fig. 1.

Genus. Ceratella. (Gray.)

Colony irregularly branching; more or less expanded in one plane; growing from a creeping base. Main stem flattened, branches rounded and beset with bracket-like hydrophores.

(2.) *Ceratella fusca.* (Gray.)

Colony branching and fan-shaped; expanded in the one plane; erect. Skeleton consisting of a light or dark-brown chitinous network; the main stem broad and flattened; branches numerous with the bracket-shaped hydrophores arranged on them in a roughly spiral manner and formed of ribs continuous with the fibres of the stem and united by thin perforated laminæ the ribs projecting at the outer margin. All the spaces within the chitinous network filled by a much branching hydrophyton and the whole enclosed by an external layer of ectoderm. Gastrozooids seated on the hydrophores, erect, with capitate tentacles irregularly scattered (10-14). Gonophores medusoid, fixed.

Localities.—Coogee, Bondi (N.S.W.), Broughton Island, Flinders Island, Lord Howe Island.

(3.) *Ceratella procumbens.* (Carter*).

Colony procumbent, thickly branched on the same plane; the larger stems chiefly on one (the lower) side, hard, flexible, of an ochre-brown colour, tinged here and there with purple. Trunk short, solid, compact, compressed vertically, soon dividing irregularly or subdichotomously into round branches which are confined to the lower surface, ending in branchlets with sub-clavate ends, that appear on the upper or opposite side, not reuniting or anastomosing. Hydrophores consisting of a little semitubular plate, extending outwards and forwards from the side of the stem on the proximal border of an aperture in the latter; scattered thickly over all the branches, but most prominent on the branchlets; frequently represented by the little hole alone in the stem where the projecting portion has been worn off; scanty on the lower side of the main stems. *Minute structure;* composed of clathrate chitinous fibre throughout, whose meshes are subrectangular; hydrophore formed of the semitubular scoop-like plate mentioned supported on its proximal side by an extension of the clathrate structure of the stem and bordering the little hole also above mentioned, which extends into the centre of the stem; surface of the larger stems bluntly microspined. Size of largest specimens 11 inches long by 5 inches broad, and about 1 inch thick or vertically.

Locality.—Cape of Good Hope, Natal.

* Ann. and Mag. Nat. Hist., 1873. Transformation of an entire shell into chitinous structure by the Polype Hydractinia, with short descriptions of the Polypidoms of five other species (Pl. 1). The descriptions of *C. procumbens*, *C. spinosa* and *Chitina ericopsis* are taken with only slight alterations from this paper.

(4) *Ceratella spinosa.* (Carter.)

Colony procumbent; thickly branched hard flexible of a dark rich red-purple colour. Main branches round, brownish, covered with small, smooth, often subspatulate erect spines. Stem dividing subdichotomously into purple branchlets, which terminate in abruptly pointed extremities. Hydrophores the same as in the foregoing species; most prominent in the round branchlets to which they give, *en profil*, a serrate somewhat sertularian appearance, the teeth of which are inclined forward. *Minute structure:* Main stems composed of clathrate chitinous fibre, of which the meshes are more or less oblong, passing into prominent longitudinal lines on the branchlets where they terminate on the backs of the semitubular plates which respectively form the floors of the hydrophores, to which they thus give support. Size of specimen, which is merely a branch 4½ inches long by 2 broad.

Locality.—Port Natal.

Mr. Carter adds that "the spines on the surface distinguish this from the foregoing species, add to which its longer and more pointed branches, longitudinally ridged clathrate fibre and rich red-purple colour."

Genus. Chitina. (Carter.)

Colony erect, bushy, fragili flexible, fawn coloured. Trunk long, hard, irregularly round, composed of many stems united clathrately and obliquely into a cord-like bundle, which divides and subdivides irregularly into branches which again unite with each other in substance (anastomose) when in contact and finally form a straggling bushy head. Hydrophores long clathrate tubular, terminating the ends of the branchlets, or prolonged from some of the proliferous tubercles which beset the surface of the trunk and larger stems. *Minute structure:* Composed of clathrate chitinous fibre throughout, whose network is subrectangular and massive in the stems, where there is no difference between the centre and circumference, with the exception that the fibre is stouter in the former or oldest part; hydrophores composed of several longitudinal fibres or ridges lattice-worked together transversely into a tubular form, somewhat contracted at the extremity, in the centre of which is an aperture of the meshwork a little larger than the rest. Height of specimens about 14 inches, trunk about 1 inch in diameter; hydrophores averaging 1-3rd of an inch long by 1-60th of an inch in its broadest part and an aperture 1-90th of an inch in diameter.

(5) *Chitina ericopsis.* (Carter.)

The description of the species is the same as that of the genus.

Locality.—New Zealand.

Description of Plates.

PLATE II.

Fig. 1.—*Ceratella fusca.* Life size. The specimen of which this is a drawing was washed up on Flinders Island, Bass Straits. The main stem of the colony springs from a root-like structure made up of intertwined branches. On the left side arises from the roots a very small independent stem.

Fig. 2.—Transverse section through a portion of the wall of an expanded gastrozooid. Externally is the layer of ectoderm consisting of cubical cells. The mesoglœa is an extremely thin layer and the endoderm consists of large vacuolate cells with granular protoplasm aggregated at their inner ends which face into the gastral cavity. The nuclei are conspicuous and placed at the same end. Camera. Zeiss E, oc. 2.

Ect. ectoderm. *End.* endoderm. *M.* mesoglœa.

Fig. 3.—A small portion of the external surface of a branch in the region in which gonophores are numerous to show the external ectoderm containing thread cells and a portion of one of the cœnosarc tubes. In the latter the endoderm forms a definite layer of darkly-stained, small cubical cells. Surrounding this is the ectoderm in contact with the external layer and containing developing thread cells.

E. external layer of ectoderm. *Ect.* ectoderm of cœnosarc tube. *End.* endoderm. *A.* developing thread cells. *Sk.* skeleton. Camera. Zeiss E, oc. 2.

Fig. 3a.—Developing thread cells found in the ectoderm within the branches. a. an ectoderm cell in which the nucleus is slightly larger than usual and appears homogeneous. b. the nucleus has increased in size, stains very darkly, lies at one end and is surrounded by a clear space. c. the nucleus begins to show a darker spot within it. d. two darkly-staining thread-like structures are present. e. the nucleus (?) does not stain so deeply, and is not surrounded by a clear space but has a small amount of protoplasm clinging to it; within it at the somewhat pointed extremity can be seen a light line indicating the larger terminal part of the thread. f. the wall of the thread-cell and the thread itself are clear. 9. The fully developed thread-cell.

PLATE III.

Fig. 4.—Portion of a small branch with the zooids expanded. The skeleton is covered by the soft parts but the dark lines indicate the external parts of the chitinous network which show through the soft structures.

Fig. 5.—Portion of the skeleton of a somewhat larger branch showing the chitinous network of which it is composed and the little bracket-like hydrophores. (*Hy.*) x 12.

Fig. 6.—Highly magnified small portion of a branch seen partly by direct and partly by transmitted light. Two gastrozooids are shown each of which is placed upon a hydrophore. The latter shows prominent ribs which project beyond the margin and are connected by a thin fenestrated web of chitin. Two male gonophores arise from the cœnosarc and they and the gastrozooids are quite naked. The whole branch is covered by a thin external layer of ectoderm. x 20.

G. gastrozooids. *Gon.* gonophore. *E.* external layer of ectoderm. *Hy.* hydrophore. *Hy.'* web connecting the ribs of the latter.

Fig. 7.—Transverse section across the body of a gastrozooid. The tentacles are solid with swollen ectoderm ends filled with thread cells. The zooid has been feeding and the endoderm cells are full of little food particles. *F.*—Remnant of small crustacean on which the zooid is feeding. It lies close against the endoderm on one side and the food particles are passing into the interior of the cells. Outline drawn with Camera, Zeiss E, oc. 2.

Fig. 8.—Transverse section across a gonophore. *Mn.* endoderm of the manubrium. *Sp.* sperm cells in the ectoderm of the latter. *Ect.* ectoderm of the medusa. *R.* radial canals. *Ect'.* ectoderm of the sub-umbrella surface. Outline drawn with Camera, Zeiss E, oc. 2.

PLATE IIIA.

Fig. 9.—Semi-diagrammatic drawing of a longitudinal section through a small branch. The skeleton is coloured brown the soft parts grey. *E.* external layer of ectoderm. *Gon.* gonophore. *G.* gastrozooid. *Hy.* hydrophore. *Sk.* general network of skeleton cut across in various directions. Outline drawn with Camera, Zeiss A*, oc. 2.

Fig. 10.—Semi-diagrammatic drawing of a transverse section across a good-sized branch. Letters as in figure 9. *Ect.* ectoderm of endosarc tubes. *End.* endoderm. Outline drawn with Camera, Zeiss A*, oc. 2.

Fig. 11.—More highly magnified portion of a branch cut in transverse section. The ectoderm of the gastrozooid is directly continuous with the external layer of the branch and the base of the zooid is continuous with two of the cœnosarc tubes. At *C.* is represented the characteristic feature of the latter crossing over five connecting strands of the chitinous network. *C.* points at which the soft parts

cross thin connecting strands of the skeleton. *E.* external layer of ectoderm. *Ect.* general ectoderm. *G.* gastrozooid. *Hy.* hydrophore. *Sk.* general skeleton. Outline drawn with Camera, Zeiss A*, oc. 2.

Fig. 12.—Portion of a longitudinal section of a branch from which arise two gonophores. The latter are cut in longitudinal section. *E.* external layer continuous with the ectoderm of the gonophore. *End.* endoderm of the manubrium. *Ect.* ectoderm. *Ect'.* ectoderm of sub-umbrella layer of the medusa. *G.* gastrozooid. *M.* point at which the ectoderm dips in corresponding to the mouth of the medusa. *R.* radial canals. Outline drawn with Camera, Zeiss C, oc. 2.

Fig. 13.—Longitudinal section of a branch from which another small one arises. In this specimen the skeleton has more than usual a more or less definite arrangement into ribs which run parallel to the length of the branch and are connected by transverse bands. Outline drawn with Camera, Zeiss A*, oc. 2.

Fig. 13A.—A small portion of the small branch in figure 13 more highly magnified to show the single cœnosarc tube passing along the centre. The ectoderm is irregular. Letters as before. Drawn under Zeiss F, oc. 2.

Fig. 14.—Portion of a terminal branch devoid of zooids. Up the centre runs a single tube with an internal unicellular layer of endoderm and an irregular ectoderm. The endoderm gives off hollow processes which at certain parts (x) come into direct contact with the external ectoderm (*E*). Further growth of these will probably give rise to the gastrozooids the external layer of the colony thus forming their ectoderm. Drawn under Zeiss E, oc. 2.

Fig. 3.

Fig. 3a.

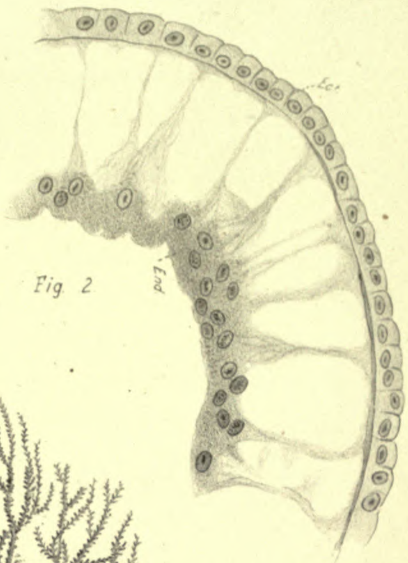

Fig. 2.

Fig. 1.

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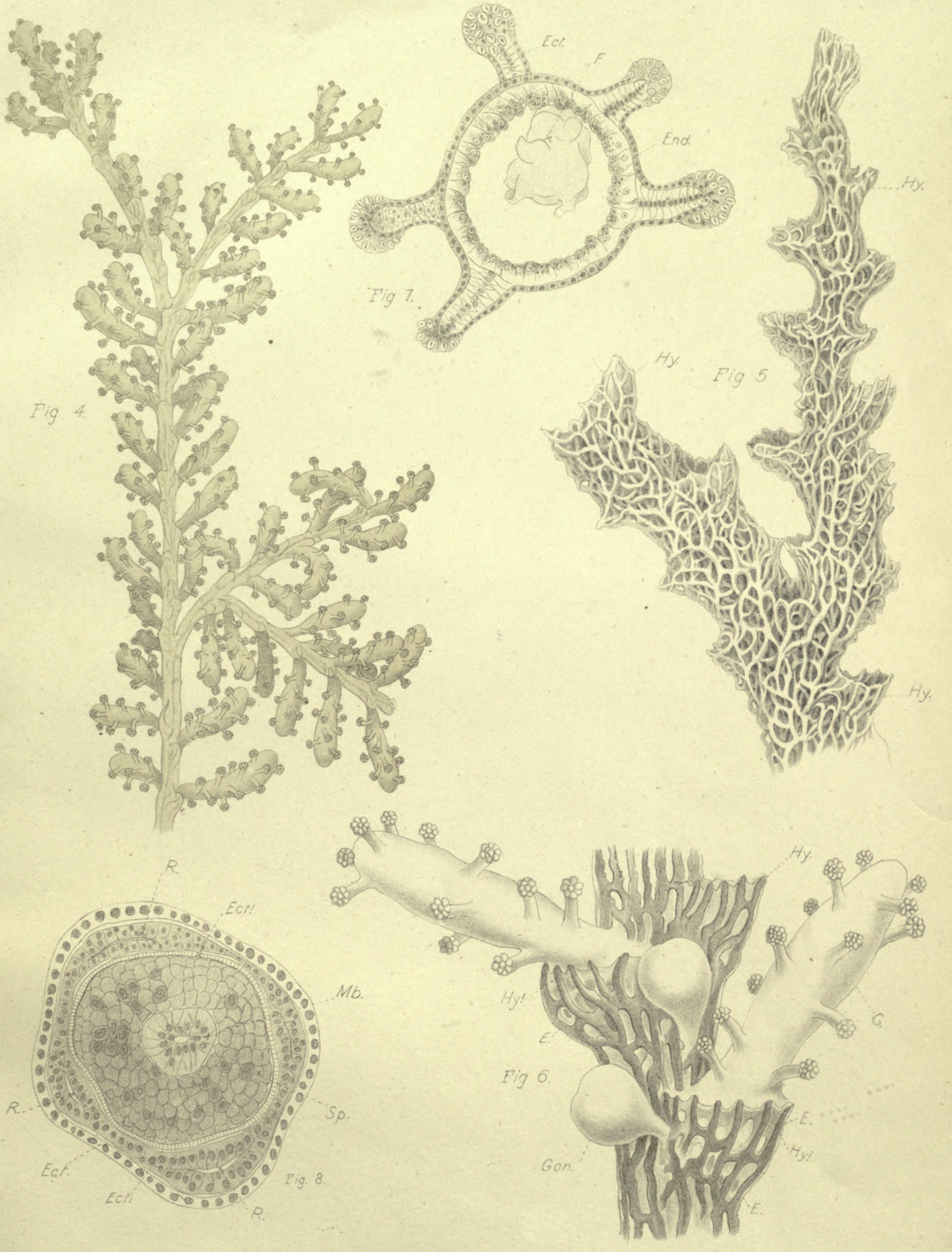

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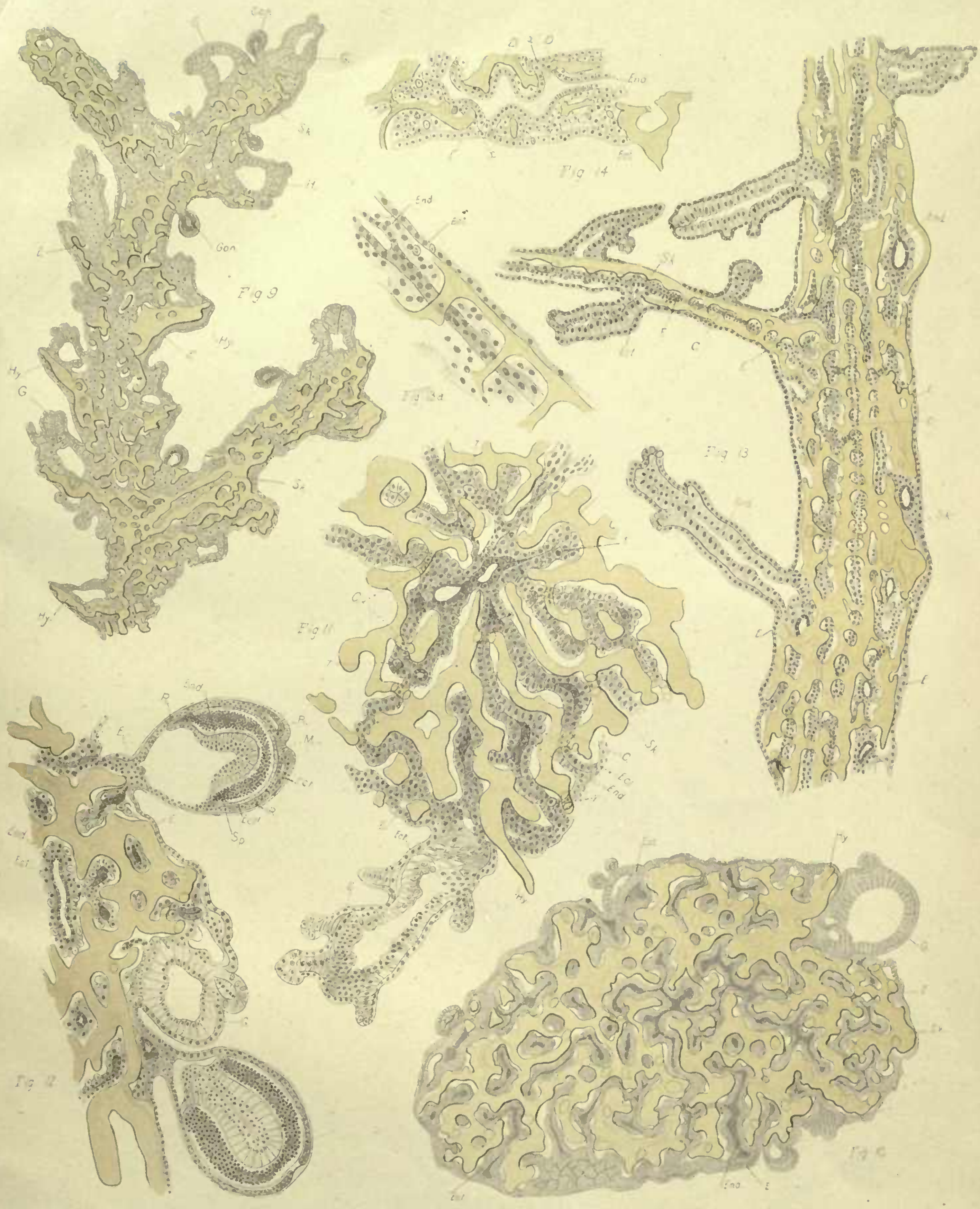

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